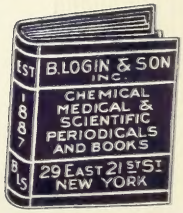
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of the

American Ophthalmological Society

Fifty-Fifth Annual Meeting

ATLANTIC CITY, N. J., 1919

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American Ophthalmological Society
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OFFICERS AND COUNCIL

of the

American Ophthalmological Society

Elected at the Annual Meeting, June 16, 1919

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1885–1889 Dr. William F. Norris, Philadelphia.
1890–1893 Dr. Hasket Derby, Boston, Mass.
1894–1898 Dr. George C. Harlan, Philadelphia.
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1908 Dr. Samuel D. Risley, Philadelphia.
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1915 Dr. M. H. Post, St. Louis, Mo.
1916 Dr. George E. de Schweinitz, Philadelphia.
1917 Dr. Peter A. Callan, New York.
1918 Dr. William H. Wilder, Chicago, Ill.
1919 Dr. Lucien Howe, Buffalo, N. Y.

American Ophthalmological Society.

FOUNDED 1864.

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* Associate Members. O. M. Original Members.

Elected.	Name.	Residence.	Place.
1896	Dr. A. E. Adams,	Balmville, Cor. North,	Newburg, N. Y.
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1899	Dr. A. N. Alling,	257 Church Street,	New Haven, Conn.
1896	Dr. G. W. Allyn,	Empire Building,	Pittsburgh, Pa.
1882	Dr. A. Alt,	5614 Waterman Ave.,	St. Louis, Mo.
1883	Dr. J. A. Andrews,	1229 State Street,	Santa Barbara, Cal.
1913	Dr. Fred. D. Bailey,	260 Hancock Street,	Brooklyn, N. Y.
1911	Dr. Arthur J. Bedell,	344 State Street,	Albany, N. Y.
1908	Dr. Geo. H. Bell,	40 East 41st Street,	New York, N. Y.
1905	Dr. Jas. H. Bell,	Moore Building,	San Antonio, Texas.
1916	*Dr. Eugene M. Blake,	55 Trumbull Street,	New Haven, Conn.
1909	Dr. James Bordley, Jr.,	330 N. Charles Street,	Baltimore, Md.
1881	Dr. H. W. Bradford,		Wolfboro, N. H.
1918	*Dr. H. H. Briggs,	73 Haywood Street,	Asheville, N. C.
1908	Dr. E. V. L. Brown,	122 S. Michigan Blvd.,	Chicago, Ill.
1907	Dr. Wm. E. Bruner,	Guardian Bldg.,	Cleveland, Ohio.
1901	Dr. H. D. Bruns,	211 Camp Street,	New Orleans, La.
1906	Dr. W. K. Butler,	1207 M Street, N. W.,	Washington, D. C.
1906	Dr. W. Gordon M. Byers,	346 Mountain Street,	Montreal, Canada.
1918	*Dr. F. Phinizy Calhoun,	Candler Building,	Atlanta, Ga.
1909	Dr. L. W. Callan,	452 Fifth Avenue,	New York, N. Y.
1876	Dr. Peter A. Callan,	452 Fifth Avenue,	New York, N. Y.
1885	Dr. F. P. Capron,	118 Angell Street,	Providence, R. I.
O. M.	Dr. W. H. Carmalt,	261 St. Ronan Street.	New Haven, Conn.
1898	Dr. J. T. Carpenter,	2039 Chestnut Street,	Philadelphia, Pa.
1904	Dr. Burton Chance,	255 So. 13th Street,	Philadelphia, Pa.
1893	Dr. H. B. Chandler,	34½ Beacon Street,	Boston, Mass.
1904	Dr. J. W. Charles,	509 Humboldt Bldg.,	St. Louis, Mo.
1893	Dr. F. E. Cheney,	64 Commonw'th Ave.,	Boston, Mass.
1898	Dr. J. H. Claiborne,	8 West 40th Street,	New York, N. Y.

Elected.	Name.	Residence.	Place.
1912	Dr. E. W. Clap,	390 Commonw'th Ave.,	Boston, Mass.
1891	Dr. C. F. Clark,	188 East State Street,	Columbus, Ohio.
1912	*Dr. G. S. Crampton,	1700 Walnut Street,	Philadelphia, Pa.
1890	Dr. C. M. Culver,	36 Eagle Street,	Albany, N. Y.
1906	Dr. R. J. Curdy,	1134 Rialto Building,	Kansas City, Mo.
1902	Dr. Colman W. Cutler,	24 East 48th Street,	New York, N. Y.
1907	Dr. A. E. Davis,	47 East 57th Street,	New York, N. Y.
1878	Dr. W. S. Dennett,	8 East 49th Street,	New York, N. Y.
1918	*Dr. David N. Dennis,	221 West 9th Street,	Erie, Pa.
1909	Dr. George S. Derby,	7 Hereford Street,	Boston, Mass.
1874	Dr. Lewis S. Dixon,	232 Clarendon Street,	Boston, Mass.
1912	Dr. Oscar Dodd,	30 N. Michigan Blvd.,	Chicago, Ill.
1902	Dr. Alexander Duane,	139 E. 37th Street,	New York, N. Y.
1908	Dr. J. L. Duncan,	Jenkins Bldg.,	Pittsburgh, Pa.
1912	Dr. E. C. Ellett,	Exchange Building,	Memphis, Tenn.
1887	Dr. J. B. Emerson,	40 East 41st Street,	New York, N. Y.
1890	Dr. Arthur E. Ewing,	Metropolitan Bldg.,	St. Louis, Mo.
1896	Dr. T. H. Fenton,	1319 Spruce Street,	Philadelphia, Pa.
1915	*Dr. Carl Fisher,	102 S. Franklin Street,	Rochester, Minn.
1893	Dr. George F. Fiske,	25 E. Washington Street,	Chicago, Ill.
1909	Dr. M. L. Foster,	106 Centre Avenue,	New Rochelle, N.Y.
1904	Dr. W. H. Fox,	1826 Jefferson Place,	Washington, D. C.
1913	Dr. Lee M. Francis,	636 Delaware Avenue,	Buffalo, N. Y.
1902	Dr. Percy Fridenberg,	38 West 59th Street,	New York, N. Y.
1894	Dr. H. Friedenwald,	1029 Madison Ave.,	Baltimore, Md.
1913	Dr. H. G. Goldberg,	1925 Chestnut Street,	Philadelphia, Pa.
1895	Dr. G. M. Gould,	215 Atlantic Avenue,	Atlantic City, N. J.
1896	Dr. H. Y. Grant,	Falls View,	Ontario, Canada.
1919	*Dr. John Green, Jr.,	626 Metropolitan Bldg.,	St. Louis, Mo.
1908	Dr. L. S. Greene,	1624 I Street, N. W.,	Washington, D. C.
1905	Dr. Allen Greenwood,	101 Newbury Street,	Boston, Mass.
1914	Dr. J. Milton Griscom,	1925 Chestnut St.,	Philadelphia, Pa.
1892	Dr. G. W. Hale,	210 Hitchcock Building,	Nashville, Tenn.
1895	Dr. Wm. D. Hall,	416 Marlborough Street,	Boston, Mass.
1887	Dr. H. F. Hansell,	17th and Walnut Streets,	Philadelphia, Pa.
1918	*Dr. D. F. Harbridge,	Goodrich Building,	Phoenix, Ariz.
1918	*Dr. Wm. F. Hardy,	Metropolitan Bldg.,	St. Louis, Mo.
1901	Dr. Herbert Harlan,	516 Cathedral Street,	Baltimore, Md.
1889	Dr. David Harrower,	13 Elm Street,	Worcester, Mass.
1896	Dr. N. D. Harvey,	114 Waterman Street,	Providence, R. I.
1904	Dr. H. H. Haskell,	29 Commonwealth Ave.,	Boston, Mass.
1914	Dr. Edw. B. Heckel,	Jenkins Building,	Pittsburgh, Pa.
1913	Dr. Chas. R. Heed,	1205 Spruce Street,	Philadelphia, Pa.
1896	Dr. Ward A. Holden,	8 East 54th Street,	New York, N. Y.
1909	Dr. T. B. Holloway,	1819 Chestnut Street,	Philadelphia, Pa.

Elected.	Name.	Residence.	Place.
1906	Dr. C. R. Holmes,	8 East 8th Street,	Cincinnati, Ohio.
1883	Dr. E. E. Holt,	723 Congress Street,	Portland, Me.
1917	*Dr. Harvey J. Howard,	Union Medical College,	Peking, China.
1878	Dr. Lucien Howe,	520 Delaware Avenue,	Buffalo, N. Y.
1891	Dr. D. W. Hunter,	80 West 40th Street,	New York, N. Y.
1898	Dr. J. W. Ingalls,	874 Lafayette Avenue,	Brooklyn, N. Y.
1895	Dr. E. E. Jack,	215 Beacon Street,	Boston, Mass.
1885	Dr. Edward Jackson,	318 Majestic Building,	Denver, Col.
1912	Dr. P. C. Jameson,	139 Montague Street,	Brooklyn, N. Y.
1918	*Dr. J. Wilkinson Jervey,	Jervey-Jordan Bldg.,	Greenville, S. C.
1892	Dr. W. B. Johnson,	170 Broadway,	Paterson, N. J.
1908	Dr. B. R. Kennon,	Taylor Building,	Norfolk, Va.
1919	*Dr. Ben Witt Key,	180 W. 59th Street,	New York, N. Y.
1901	Dr. H. W. Kilburn,	192 Marlborough Street,	Boston, Mass.
1903	Dr. Arnold Knapp,	10 East 54th Street,	New York, N. Y.
1889	Dr. Carl Koller,	681 Madison Avenue,	New York, N. Y.
1888	Dr. Chas. W. Kollock,	86 Wentworth Street,	Charleston, S. C.
1913	Dr. Robert S. Lamb,	Stoneleigh Court,	Washington, D. C.
1891	Dr. W. E. Lambert,	112 East 35th Street,	New York, N. Y.
1902	Dr. W. B. Lancaster,	522 Commonw'lth Ave.,	Boston, Mass.
1919	*Dr. Francis Lane,	25 E. Washington Street,	Chicago, Ill.
1912	Dr. H. M. Langdon,	2018 Chestnut Street,	Philadelphia, Pa.
1903	Dr. J. C. Lester,	616 Madison Avenue,	New York, N. Y.
1907	Dr. George F. Libby,	Majestic Bldg.,	Denver, Col.
1883	Dr. J. A. Lippincott,	Jenkins Building,	Pittsburgh, Pa.
1878	Dr. F. B. Loring,	1420 K Street,	Washington, D. C.
1909	Dr. R. G. Loring,	10 Arlington Street,	Boston, Mass.
1899	Dr. D. B. Lovell,	340 Main Street	Worcester, Mass.
1914	*Dr. W. H. Lowell,	101 Newbury Street,	Boston, Mass.
1919	*Dr. W. H. Luedde,	311 Metropolitan Bldg.,	St. Louis, Mo.
1918	*Dr. Hunter H. McGuire,	105 N. Braddock Street,	Winchester, Va.
1913	Dr. A. L. Macleish,	1101 Brockman Bldg.,	Los Angeles, Cal.
1891	Dr. F. W. Marlow,	731 University Block,	Syracuse, N. Y.
1878	Dr. W. V. Marmion,	1211 13th Street, N. W.,	Washington, D. C.
1868	Dr. Arthur Mathewson,	Cosmos Club,	Washington, D. C.
1905	Dr. S. C. Maxson,	235 Genesee Street,	Utica, N. Y.
1907	Dr. C. H. May,	698 Madison Avenue,	New York, N. Y.
1874	Dr. C. S. Merrill,	27 S. Hawk Street,	Albany, N. Y.
1908	Dr. H. S. Miles,	417 State Street,	Bridgeport, Conn.
1883	Dr. J. Lancelot Minor,	Bank of Commerce Bldg.,	Memphis, Tenn.
1916	Dr. John H. Ohly,	22 Schermerhorn St.,	Brooklyn, N. Y.
1887	Dr. H. S. Oppenheimer,	276 Madison Avenue,	New York, N. Y.
1908	Dr. W. R. Parker,	David Whitney Bldg.,	Detroit, Mich.
1908	Dr. S. McA. Payne,	542 Fifth Avenue,	New York, N. Y.
1895	Dr. R. J. Phillips,	123 So. 39th Street,	Philadelphia, Pa.

Elected.	Name.	Residence.	Place.
1869	Dr. Thomas R. Pooley,	26 Trinity Street,	Newton, N. J.
1898	Dr. W. Campbell Posey,	2049 Chestnut Street,	Philadelphia, Pa.
1895	Dr. H. R. Price,	435 Clinton Avenue,	Brooklyn, N. Y.
1906	Dr. Brown Pusey,	7 West Madison Street,	Chicago, Ill.
1902	Dr. Walter L. Pyle,	1931 Chestnut Street,	Philadelphia, Pa.
1901	Dr. Alex. Quackenboss,	143 Newbury Street,	Boston, Mass.
1906	Dr. McCluney Radcliffe,	1906 Chestnut Street,	Philadelphia, Pa.
1885	Dr. Alex'r Randall,	1717 Locust Street,	Philadelphia, Pa.
1892	Dr. R. L. Randolph,	609 Park Avenue,	Baltimore, Md.
1901	Dr. R. G. Reese,	50 West 52nd Street,	New York, N. Y.
1899	Dr. H. O. Reik,	300 E. 30th Street,	Baltimore, Md.
1912	Dr. W. G. Reynolds,	1165 Dean Street,	Brooklyn, N. Y.
1884	Dr. Stephen O. Richey,	732 17th Street,	Washington, D. C.
1901	Dr. G. O. Ring,	17th and Walnut Streets,	Philadelphia, Pa.
1895	Dr. H. W. Ring,	185 Church Street,	New Haven, Conn.
1908	Dr. J. Norman Risley,	36 7th Street,	New Bedford, Mass.
1880	Dr. Samuel D. Risley,	2018 Chestnut Street,	Philadelphia, Pa.
1900	Dr. Wm. K. Rogers,	188 East State Street,	Columbus, Ohio.
1899	Dr. Dunbar Roy,	Gr. Opera House Blk.,	Atlanta, Ga.
1875	Dr. John D. Rushmore,	129 Montague Street,	Brooklyn, N. Y.
1880	Dr. Robert Sattler,	30, The Groton,	Cincinnati, Ohio.
1912	Dr. A. C. Sautter,	1421 Locust Street,	Philadelphia, Pa.
1898	Dr. T. B. Schneideman,	1831 Chestnut Street,	Philadelphia, Pa.
1919	*Dr. M. J. Schoenberg,	103 E. 84th Street,	New York, N. Y.
1889	Dr. G. E. de Schweinitz,	1705 Walnut Street,	Philadelphia, Pa.
1895	Dr. P. N. K. Schwenk,	1417 North Broad St.,	Philadelphia, Pa.
1918	*Dr. Wm. E. Shahan,	Metropolitan Bldg.,	St. Louis, Mo.
1913	Dr. C. E. G. Shannon,	1633 Spruce Street,	Philadelphia, Pa.
1905	Dr. John R. Shannon,	17 East 38th Street,	New York, N. Y.
1916	*Dr. Francis W. Shine,	24 East 48th Street,	New York, N. Y.
1911	Dr. J. F. Shoemaker,	1006 Carleton Bldg.,	St. Louis, Mo.
1902	Dr. Wm. A. Shoemaker,	1006 Carleton Bldg.,	St. Louis, Mo.
1902	Dr. Wm. T. Shoemaker,	109 South 20th Street,	Philadelphia, Pa.
1905	Dr. E. A. Shumway,	2046 Chestnut Street,	Philadelphia, Pa.
1918	*Dr. Dorland Smith,	834 Myrtle Avenue,	Bridgeport, Conn.
1912	Dr. E. T. Smith,	36 Pearl Street,	Hartford, Conn.
1910	Dr. Albert C. Snell,	53 S. Fitzhugh St.,	Rochester, N. Y.
1909	Dr. F. M. Spalding,	128 Newbury Street	Boston, Mass.
1878	Dr. J. A. Spalding,	627 Congress Street,	Portland, Me.
1911	*Dr. Chas. N. Spratt,	900 Nicollet Avenue,	Minneapolis, Minn.
1884	Dr. Myles Standish,	72 St. James Avenue,	Boston, Mass.
1873	Dr. George T. Stevens,	40 East 41st Street,	New York, N. Y.
1903	Dr. Edw. Stieren,	Union Arcade Bldg.,	Pittsburgh, Pa.
1887	Dr. T. Y. Sutphen	992 Broad Street,	Newark, N. J.

Elected.	Name.	Residence.	Place.
1900	Dr. Wm. M. Sweet,	1205 Spruce Street,	Philadelphia, Pa.
1917	*Dr. William Tarun,	605 Park Ave.,	Baltimore, Md.
1888	Dr. Lewis H. Taylor,	83 So. Franklin Street,	Wilkesbarre, Pa.
1880	Dr. Samuel Theobald,	Cathedral & How'd Sts.,	Baltimore, Md.
1893	Dr. Ch. Hermon Thomas,	3634 Chestnut Street,	Philadelphia, Pa.
1903	Dr. Edgar S. Thomson,	405 Park Avenue,	New York, N. Y.
1898	Dr. Jas. Thorington,	2031 Chestnut Street,	Philadelphia, Pa.
1911	Dr. Fred. T. Tooke,	368 Mountain Street,	Montreal, Canada
1912	*Dr. E. Török,	8 East 54th Street,	New York, N. Y.
1906	Dr. H. H. Tyson,	11 East 48th Street,	New York, N. Y.
1916	Dr. Derrick T. Vail,	24 East 8th Street,	Cincinnati, Ohio.
1898	Dr. C. A. Veasey,	Paulsen Building,	Spokane, Wash.
1905	Dr. F. H. Verhoeff,	101 Newbury Street,	Boston, Mass.
1903	Dr. F. L. Waite,	68 Pratt Street,	Hartford, Conn.
1916	*Dr. Clifford B. Walker,	721 Huntington Avenue,	Boston, Mass.
1873	Dr. David Webster,	24 East 48th Street,	New York, N. Y.
1893	Dr. J. E. Weeks,	46 East 57th Street,	New York, N. Y.
1914	Dr. Walter B. Weidler,	137 East 60th Street,	New York, N. Y.
1900	Dr. C. D. Wescott,	1360 E. 58th Street,	Chicago, Ill.
1916	*Dr. John M. Wheeler,	80 West 40th Street,	New York, N. Y.
1891	Dr. Edward Wheelock,	26 Gibbs Street,	Rochester, N. Y.
1892	Dr. J. A. White,	200 E. Franklin Street,	Richmond, Va.
1919	*Dr. Lloyd B. Whitham	514 Cathedral Street,	Baltimore, Md.
1895	Dr. W. H. Wilder,	1417 Peoples Gas Bldg.,	Chicago, Ill.
1910	Dr. Carl Williams,	School L. & Greene St.,	Philadelphia, Pa.
1912	Dr. Edw. R. Williams,	1069 Boylston Street,	Boston, Mass.
1893	Dr. Wm. H. Wilmer,	1610 I Street, N. W.,	Washington, D. C.
1906	Dr. J. Scott Wood,	172 Sixth Avenue,	Brooklyn, N. Y.
1900	Dr. Hiram Woods,	842 Park Avenue,	Baltimore, Md.
1915	*Dr. H. W. Wootton,	319 Lexington Avenue,	New York, N. Y.
1881	Dr. J. P. Worrell,	20 South 7th Street,	Terre Haute, Ind.
1905	Dr. Wm. Zentmayer,	1506 Spruce Street,	Philadelphia, Pa.
1903	Dr. S. Lewis Ziegler,	1625 Walnut Street,	Philadelphia, Pa.
	Total		197

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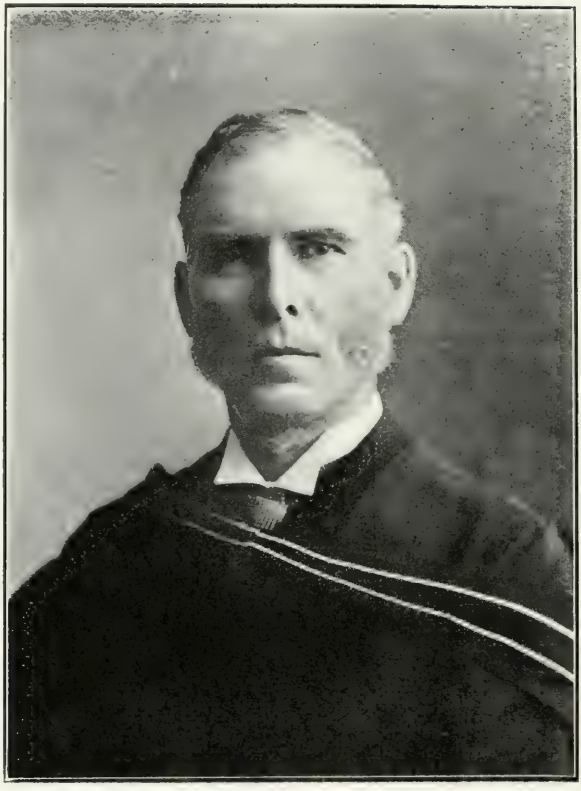
1868	Dr. J. S. Prout,	Fishkill,	Dutchess Co., N.Y.
O. M.	Dr. F. P. Sprague,	229 Commonw'lth Ave.,	Boston, Mass.

Whole number 199

IN MEMORIAM

DR. W. F. MITTENDORF, elected 1881
DR. RICHARD A. REEVE, elected 1889
DR. J. M. RAY, elected 1891



Richard Andrews Reeve, B.A., M.D., LL.D.

NECROLOGY.

RICHARD ANDREWS REEVE, B.A., M.D., LL.D.

FRED T. TOOKE, M.D.,
Montreal, Canada.

At midnight on the twenty-seventh of January, 1919, there passed into the Great Beyond a professional gentleman and a man who could be regarded by all classes as truly great.

Richard Andrews Reeve was born in Toronto, Ontario, in 1842, of Yorkshire stock. He was educated at the University of Toronto, where he was a classmate and life-long friend of the late Principal Louden. Both men graduated together, Louden selecting a university career, while Reeve's choice was "Not shelter, but the fray." He followed his medical course at Queen's University, Kingston. Shortly after graduation he was elected a Fellow of the Royal College of Physicians and Surgeons. In 1867 he joined a brother-in-law, Dr. Abner M. Rosebrugh, in the practice of his chosen specialty, and was appointed assistant at the Toronto Eye and Ear Infirmary. In 1872 he was lecturing on his specialty at the Toronto School of Medicine, resigning as professor about four years ago. His general training had been many-sided. The mutual relationship of ophthalmology and general medicine was ever before him. He was an acute diagnostician and a skilled operator, and well deserved the regard and esteem of a host of professional admirers both at home and abroad.

Among Dr. Reeve's honorary distinctions should be men-

tioned M.D., Toronto (ad eundem), 1895; LL.D., Toronto, 1912; McGill, 1911; Birmingham, 1911, when he received the degree with Mr. Lloyd George. He was a Foundation Fellow of the American College of Surgeons. He was elected Dean of the Faculty of Medicine at Toronto University in 1896. For several years he was president of the Alumni Society of the University, and practically founded Convocation Hall. He established the Reeve Scholarship in the University, and was a Past President of the British Medical Association, the Canadian Medical Association, and the Academy of Medicine.

Dr. Reeve was a gentleman, because he was courteous and because he was kindly. The dignified and natural appreciation of all that makes for good, not only in his chosen sphere of work, but in the world at large, marked him out as one of Canada's really great men. To wear the honors and assume the dignities and responsibilities which were his with such simplicity and charm of manner was a quality characteristic of the man. He had a horror of anything savoring of unconventionality in a professional or social sense. His native modesty compelled an avoidance of display or the attraction of attention. He was a profoundly religious man; there was nothing austere or self-righteous about his religious observances, and if the love of God had not blessed him, it would have been the love and regard of his fellow-man. Self-knowledge, self-reverence, and self-control were his to a high degree.

In a recent lecture on medical ethics to a graduating class he said: "You may naturally regard the Golden Rule as covering all duties, and therefore all sufficient. Besides, it has the merit of simplicity, which is a quality of perfection." Such an article of faith exemplified the man's life under all circumstances and under all conditions.

Although a member of what we are apt to regard with all due respect as the old school, he kept wonderfully abreast

of the times, and was keenly sensible and appreciative of any advance in laboratory work undertaken by his younger colleagues. He was a noteworthy example in his regular attendance at medical society meetings. He regarded his attendance at the American Ophthalmological Society as a privilege and a pleasure, but in his own country, where meetings of very minor importance were frequently held, he always regarded it as a duty to be present as an example to the younger men.

He died, as no doubt he would have wished, with health, vigor, and faculties unimpaired up to the last. His life had been one of service. With war complications and difficulties before us, it was only natural for him to step forward and to assume added duties which were beyond a man of his years. On the night of his death he had presided over a meeting intended to establish an undenominational native school of medicine in China. From this meeting he proceeded to the University to consider the erection of a suitable memorial to its members who had fallen in the war. He was found dead on the road home a short time later.

His death marks the passing of the last of a triumvirate of the senior Canadian members of this Society, MacIntosh, Buller, Reeve. As such his death is generally regretted, but more particularly by his fellow-members from his own country.

He is survived by one brother, an octogenarian of Florida, and by two sisters, Mrs. A. M. Rosebrugh, of Toronto, and Mrs. Michael Lavelle, of Kingston, the mothers of distinguished sons. To these the sympathy of this Society goes out in fullest measure and in fraternal pride.

MINUTES OF THE PROCEEDINGS.

FIFTY-FIFTH ANNUAL MEETING.

THE MARLBOROUGH-BLENHEIM,
Atlantic City, N. J., June 14, 1919.

The Fifty-fifth Annual Meeting of the Society was called to order at 9 A. M. by the President, Dr. Lucien Howe, of Buffalo, N. Y.

President's address.

The following papers were read and discussed:

1. "Requirements and Experiences in Ocular Examinations for the Army." Wm. H. Wilder, M.D., Chicago.

Discussed by Drs. Ellett, Greenwood, and Wilder.

2. "The Eyes of the Signalman." Alexander Duane, M.D., New York.

Discussed by Dr. Duane.

3. "A Brief History of the Formation of the Division of Head Surgery, with Special Reference to Ophthalmology." Walter R. Parker, M.D., Detroit.

Discussed by Drs. Greenwood and de Schweinitz.

4. "Ocular Manifestations Following Exposure to Various Types of Poisonous Gases." George S. Derby, M.D., Boston.

Discussed by Drs. Verhoeff, Lancaster, Greenwood, Jackson, Nelson M. Black, and Derby.

5. "Primary Treatment of War Injuries of the Lids and Orbit." Allen Greenwood, M.D., Boston.

Discussed by Drs. Derby, de Schweinitz, Jackson, Nelson M. Black, and Greenwood.

6. "Penetrating and Perforating Wounds of the Eyeball

with Diagnosis and Treatment of Retained Foreign Bodies." William T. Shoemaker, M.D., Philadelphia.

Discussed by Drs. Verhoeff, Theobald, Derby, Clark, Nelson M. Black, Tarun, Greenwood, and Holloway.

7. "Concerning the Ocular Phenomena in the Psychoneuroses of Warfare." G. E. de Schweinitz, M.D., Philadelphia.

Discussed by Drs. Wilder, Greenwood, and de Schweinitz.

The following were invited to be guests of the Society and take part in the discussions: Major Fernard Le Maitre, Paris, Chief of the Centre of Facial Reconstruction of the French Army; Colonel Antoine DuPage, of the Belgian Medical Corps; Dr. Ryuzo Kodama, Associate Professor of Ophthalmology, Tohoku Imperial University, Japan; and Drs. Jas. H. Andrew, N. W. Ball, W. C. Bane, W. L. Benedict, Conrad Berens, Jr., Edmond E. Blaauw, Nelson M. Black, Wm. W. Blair, M. A. Bliss, Jas. N. Buchanan, B. C. Catlin, Franklin Chattin, Percy W. Cobb, Martin Cohen, D. O. Connor, Walter Cox, Geo. E. Deely, Perc. Dolman, Jesse W. Downey, John H. Dunnington, Robert Fechtig, Geo. A. Fleming, F. M. Fernandes, C. Gertrude French, A. S. Green, John Green, Jr., Edw. F. Ganaghan, J. P. Harbert, Herbert Harlan, Revere, Ind., C. E. Hill, J. Harrison Hodges, L. W. Jessaman, W. O. La Motte, C. L. La Rue, N. B. Lemere, A. C. Magruder, C. L. Maine, Wm. H. Mercur, Mead Moore, D. D. McHenry, R. Nebinger, Adolph Pfingst, Elbert S. Sherman, Louisa P. Tingley, M. Uribe Troncoso, Will Walter, C. G. Weber, David W. Wells, and W. P. Wherry.

AFTERNOON SESSION, JUNE 14TH.

8. "Trachoma in the Camps and Hospitals of the Army." Burton Chance, M.D., Philadelphia.

Discussed by Drs. Wilder, Nelson M. Black, and Chance.

9. "Ocular Complications Due to Typhoid Inoculations." Major F. Phinizy Calhoun, M.C., Fort McPherson, Ga.

Discussed by Drs. G. H. Bell and Lancaster.

10. "Further Experience in the Ocular Function of Aviators." W. H. Wilmer, M.D., Washington, D. C.

Discussed by Drs. Duane, Howard, Conrad Berens, Jr., Greenwood, Nelson M. Black, Howe, and Wilmer.

11. "Research Work in Ophthalmology at the Medical Research Laboratory of the Air Service Division of the Surgeon General's Office and Its Bearing on the Teaching of Ophthalmology in America." Walter B. Lancaster, M.D., Boston.

Discussed by Dr. Howe.

12. "A Test for the Judgment of Distance." Captain Harvey J. Howard, M.C., Mineola, L. I., N. Y.

Discussed by Drs. Duane, E. E. Blaauw, Greenwood, Wilmer, Clark, Conrad Berens, Jr., Verhoeff, David W. Wells, and Howard.

13. "The Maddox Rod Screen Test." By Captain Percival Dolman, M.C., Mineola, L. I., N. Y. (by invitation).

Discussed by Drs. Duane, Weeks, and Dolman.

14. "A Contribution to the Study of Dark-Adaptation." Captain Percy W. Cobb, M.C., Mineola, L. I., N. Y. (by invitation).

During a recess, the Atlantic-foto-Service, 173 South Kentucky Avenue, took three pictures in the garden adjoining the place of meeting. The first included members of the Society who have served or were serving as officers of the army and navy, together with one guest, Major Le Maitre, of France. The second group was composed of the members of the Society; the third, members and guests.

AFTERNOON SESSION, JUNE 15TH.

The meeting was called to order by the President at 3 P. M.

Captain Howard exhibited lantern slides, illustrating his paper on "A Test for the Judgment of Distance."

Dr. Derby exhibited slides illustrating his paper on

"Ocular Manifestations Following Exposure to Various Types of Poisonous Gases."

15. "War Injuries of the Eyelids. Plastic Operations for a Few Types of Injuries." Captain John M. Wheeler, M.C., Fort McHenry, Md.

16. "Notes on a Popular Presentation of Specimens Showing the Migration of the Eye of the Flounder and the Imperfect Eyes of Cave Fauna." Lucien Howe, M.D., Buffalo, N. Y.

17. "Introductory Remarks." Exhibition of film, "Fit to Fly." Wm. H. Wilmer, M.D., Washington, D. C.

MONDAY MORNING, JUNE 16TH, 9 O'CLOCK.

18. "Multiple Vaccination of the Eyelids." Arthur J. Bedell, M.D., Albany, N. Y.

Discussed by Drs. Taylor and Bedell.

19. "A Case of Keratitis Profunda (or Disciformis?), with Microscopic Examination." F. H. Verhoeff, M.D., Boston.

Discussed by Drs. Zentmayer, Brown, Weeks, Ryuzo Kodama, and Verhoeff.

20. "Report of Two Unusual Complications of Herpes Zoster Ophthalmicus. (a) Acute Retrobulbar Neuritis (Neuritis Axialis); (b) Acute Glaucoma." Clarence A. Veasey, M.D., Spokane, Washington.

Discussed by Drs. Knapp, de Schweinitz, Verhoeff, Greenwood, Clark, Lamb, Parker, Woods, Weeks, and Francis.

21. "Some Cases of Lethargic Encephalitis." Hiram Woods, M.D., Baltimore.

Discussed by Drs. Bedell, de Schweinitz, Shumway, Holloway, and Woods.

22. "Coloboma and So-called Congenital Dislocation of the Lens." C. F. Clark, M.D., Columbus, Ohio.

Discussed by Drs. Lambert, Davis, E. V. L. Brown, Howe, and Clark.

23. "A Case of Multiple Dermoids of the Eyeball with

Other Anomalies of Development." William Zentmayer, M.D., Philadelphia.

24. "Tuberculosis of the Retina." Edward Jackson, M.D., and (by invitation) William C. Finnoff, M.D., Denver, Col.

Discussed by Drs. Knapp, Wescott, Langdon, and Jackson.

25. "Subretinal Exudate Simulating Sarcoma of the Choroid, with Anatomic Examination." Arnold Knapp, M.D., New York.

Discussed by Drs. Verhoeff and Jackson.

26. "Atypical Disseminated Choroiditis Due to Disease of the Accessory Sinuses." John E. Weeks, M.D., New York.

Colonel Antoine DuPage, of the Belgian Medical Corps, a delegate to the American Medical Association, was introduced by former Colonel W. H. Wilmer. Colonel DuPage, speaking in French, expressed his gratification at meeting the members of the Society. He referred briefly to the ordeal through which his country had passed, but said that his compatriots had by no means lost their courage, and that the medical profession would be gradually reorganized like the rest of the country. He hoped that if Americans went to Europe again they could find in Belgium opportunities for study abundant and satisfactory.

Dr. Howe, replying in French, assured Colonel DuPage of the honor it was to receive so distinguished a guest, representing the medical profession of a country which had suffered so grievously but so bravely. He sent our greetings through him to our confrères in Belgium. He hoped that not only our students might have the benefit of the old universities in Belgium, but that in time the young men of that and of other countries would come to our own schools in America, such efforts at mutual assistance and understanding being more potent than anything else to bind together the sympathies and interests of the two countries.

EXECUTIVE SESSION, JUNE 16TH.

The meeting was called to order at 4.10 P. M., by the President, Dr. Lucien Howe, of Buffalo.

The first order of business was the reading of the Minutes of the previous Annual Meeting. As these had been printed in the Transactions, a motion was made and carried that the reading of them be dispensed with. The President made the following appointment:

Auditing Committee: Dr. William M. Sweet.

The Report of the Secretary-Treasurer was read. The Auditing Committee certified to its correctness, and it was accepted and filed.

Dr. Walter R. Parker, Chairman of the Committee on Theses, presented the following report: There were nine theses submitted for consideration by the Committee. Of these, two were rejected unconditionally, a third deferred for a year so that it could be more thoroughly developed. The reason for this action was because the candidate was in the military service. The other six were accepted.

On motion, duly seconded, the report was accepted.

Dr. William Zentmayer, Chairman of the Committee on Standardization and Illumination of Test-Cards and Perimeters, read the following report:

At a meeting of this Society held in 1917, your committee submitted a preliminary report which was largely a consideration of the laboratory and theoretic sides of the question of illumination of test-cards and perimeters. In order that the reasons for some of the present recommendations be better understood, we present, first, a résumé of that report.

It was therein stated that the factors which influence visual acuity are:

1. a. Insufficient light on the test-object. b. Too much light, or light wrongly distributed. c. Color of the light.

2. The effect of a different pupillary diameter from that under which the prescribed glasses are to be worn.

There is apparently no critical point at which visual acuity ceases to rise with increase of illumination and begins to decline with further increase. Visual acuity is an extremely slow-varying function of the brightness of object, so that the latter may undergo quite material changes without significant change in the result. Ophthalmic test charts are seldom or never designed with differences of less than 10 per cent. in size of successive lines.

Percy W. Cobb has submitted to the committee some average figures on the region in which there is no change in visual acuity. Brightness, 12.7 candles per square meter, visual acuity, 1.44; brightness, 66.3, visual acuity, 1.64. These brightnesses correspond as nearly as could be estimated from experimental conditions to illumination of 10.6 and 55 foot-candles. There is between five and six fold change in brightness with a change of 0.2 only in visual acuity. There is no reason to think that somewhat above and below this region the change would be correspondingly any greater.

It is then evident that an increase in the illumination of 30 to 60 per cent. would cause such a difference in visual acuity as could be found only by methods more refined and much more prolonged than those found necessary in the ophthalmologist's practice.

The effect of brightness in the surroundings in visual acuity is: (1) Great excess of brightness in the surroundings over that of the chart will reduce visual acuity. (2) Perfectly dark surroundings may not give as high a value as surroundings of the order of brightness of the test-object; the bright surroundings have been shown to give an advantage of 5 per cent. over the dark in some cases.

The practical solution of the task set us we have endeavored to reach through a consideration of the above facts and the study of some additional data.

1. The light should possess, as nearly as possible, the quality of daylight.

2. Its intensity should be such that, when installed, it represents the maximum of the range through which the illumination may vary without materially influencing the visibility of the test-objects.

3. It is desirable that it should be readily controlled.

4. It should be uniform in intensity and evenly distributed over the surface of the chart.

5. It should be so arranged that reflected light from the surface of the chart is deviated from a perpendicular to the chart.

6. The surroundings should be of a subdued hue, and of an order of brightness not greater than that exhibited by a moderately light gray under illumination equal to that of the test chart.

7. The chart and the patient are to be so arranged that no light-source, window, or other spot of light brightness shall be visible to the patient while he is engaged in observing the test chart.

The committee's conclusions in reference to the above requirements and desiderata, considered in their order, are:

1. The light having a spectrum most nearly approaching that of sunlight that is available for practical use is the Corning "daylite" screen, which may be obtained with either electricity or gas as the source of illumination.

2. With either of these sources of illumination the second requirement may be fulfilled.

3. The desideratum named under the third heading can be secured only by the use of electricity.

4. Either illuminant may be made to meet the fourth requirement in an equal degree, both however, unsatisfactorily, as it matters not how the lamps are arranged, certain areas of the surface of the chart are likely to be more, others less, brightly illuminated.

5. To meet the fifth requirement, variations in the arrangement of the lights adapted to the method of display of the test-objects will be required.

Your committee submit a plan for an equipment which they consider suitable for the ophthalmologist's consulting room and adaptable to the examination in centers where considerable numbers of men for government service are made. The illuminating equipment is to consist of two "daylite" lamps of 72 watts, contained in a rectangular box the back of which is concave within, the front inclosed with a removable frosted plate of glass. The lamps are placed at the upper and lower thirds of the container. The inner concave back is bright and acts as a reflector. The box may

be attached to the wall by adjustable arms, so that the distance of the box from the card may be varied and the angle of reflection of the light upon the surface of the chart altered.

Considering the question of the illumination best suited for perimetric measurements, your committee feel that there are several things which require investigation before they are in a position to make a definite recommendation, and therefore suggest that this part of the problem assigned to them be kept open for a later report.

The committee believe that the question of proper colors for the perimeter is correlated to that of proper illumination, and knowing that there is considerable variation in the tints as supplied by various makers of perimeters, they considered that an attempt to standardize them was justified, and they, therefore, requested the various makers of perimeters to submit samples of the colored papers used by them for study and comparison; these were considered from two standpoints, that of light value and spectral tone. On comparison with the spectrum, made through the courtesy of Dr. Arthur W. Goodspeed, of the Department of Physics of the University of Pennsylvania, there was but one lot of colors which in every instance proved to be a pure color; with all other series one or more colors were not pure, but contained an admixture. Since this was the series regarded as most satisfactory from a standpoint of light value, it seems to the committee that this one should be recommended. It is the one submitted by Weiss and Sons of London and printed at Heidelberg, and the one decided upon some years ago at the Heidelberg Congress.

Dr. Zentmayer then suggested the desirability of adding another member to the Committee, owing to the fact that one of the three men already on it was absent in the military service. He also submitted some samples of colored paper sent him by Weiss, of London, which had been printed at Heidelberg, but could not be procured now.

It was moved and carried that the report be accepted and printed in the Transactions, that the Committee be con-

tinued, and that the President appoint another member, in addition to the three then on the committee, in compliance with the request of its chairman.

Dr. Arnold Knapp, Chairman of the Council, made the report for that body.

The Council recommended the following named candidates for admission to the Society:

Dr. L. B. Whitham, Baltimore.

Dr. John Green, St. Louis.

Dr. Ben Witt Key, New York.

Dr. Francis Lane, Chicago.

Dr. W. H. Luedde, St. Louis.

Dr. M. J. Schoenberg, New York.

As no objection was made, they were declared elected Associate Members.

The names of other candidates were referred to the Council for 1920.

The Council recommended Dr. J. E. Weeks for reëlection to the American Board for Ophthalmic Examinations to serve for three years.

The Council confirmed the nomination of Dr. Fred. T. Tooke, to prepare a memoir of the late Dr. H. A. Reeve, to be published in the Transactions.

The Council nominated the following members to serve on the Board of Governors of the American College of Surgeons: Drs. Myles Standish, G. E. de Schweinitz, and Charles W. Kollock.

The following nominations were made for officers of the Society for the ensuing year:

President: Dr. Hiram Woods, Baltimore.

Vice-President: Dr. John E. Weeks, New York.

Secretary-Treasurer: Dr. T. B. Holloway, Philadelphia.

The Secretary was directed to cast a ballot for the nominees, and the officers were declared elected.

The Council recommended that the dues for 1919 be $10,

and suggested that Art. 6, Par. 1, of the By-Laws be changed to read: The annual subscription of members shall be $10, payable during the month of June.

The Council recommended that the meeting of the Society in 1920 be held at Hot Springs, Va., in May or June, the exact date to be later decided upon. The committee decided that Tuesday and Wednesday, June 15 and 16, 1920, be the date of the meeting at Hot Springs.

Upon motion the report of the Council with the recommendations made were adopted. The President announced that the change recommended in the By-Laws must come up for action at a subsequent session.

At this point the President, calling Dr. Woods to the chair, excused himself, and Dr. Knapp, continuing his report as Chairman of the Council, read the following statement from Dr. Howe concerning a Medal for Research:

Long experience has apparently established the fact that medals and prizes for original work in medicine tend to promote healthy rivalry and to advance our science. Although the intrinsic value of gold medals is usually less than of cash prizes, such medals are more appreciated by the older men as lasting evidence of distinguished professional service. Therefore only the question of medals interests us now—not such as are conferred on neophytes—but on investigators ripe in years and experience.

Among the institutions which award such medals for original research the following are most familiar to us: The Royal College of Physicians of London awards two. The Royal College of Surgeons of England awards the John Hunter gold medal, also an entire series known as the Blane gold medals and the Honorary medal of the College. L'Institut de France, Academie des Science, awards also medals or prizes, some of them being of unusual value. The same is true of the "Nobelstiften" of Stockholm. Numerous other medals are offered to savants in other foreign countries for researches in various branches of medicine and surgery.

In America the prizes, such as the Boylston Medical

Physicians and Surgeons of New York, are usually in money, Prize of Harvard, and the Cartwright Prize of the College of although the well-known Knapp prize is in the form of a medal.

Since the establishment of the latter, it has probably occurred to more than one of our members who is approaching the end of his activities to place a similar medal permanently within the gift of this Society. That intention has gradually taken the form of an offer of fifteen hundred dollars ($1500), the income from which is to provide a suitable gold medal and for the publication of the essay.

This is from one who for nearly forty years has shared the stimulating influence and good-fellowship of the Society.

The conditions of the gift are as follows:

First, The Society would be incorporated. According to an eminent lawyer in New York, the state in which it was organized, the incorporation is a simple formality. It involves practically no responsibility for us beyond a yearly report on our financial condition, and a trifling expense which the donor would prefer to pay.

Second, The amount mentioned would be deposited in the name of the Society with the Metropolitan Trust Company of New York, or some other trust company, with instructions to pay the interest annually to the treasurer of the American Ophthalmological Society for the purchase of a prize medal or medals. That relieves our officers of all responsibility concerning the principal.

Third, Each year the Society would select by ballot a Committee on Prize Essays, and that committee would award the prize to any writer, whether a member of this Society or not, who, according to the usual plan, is then unknown, but whose essay or communication furnishes the best evidence of (*a*) Original investigation of some phase of ophthalmology or allied branches of surgery. (*b*) The discovery of some new method of examination or treatment of the eyes.

Fourth, If that committee decides that no communication presented during a given year is worthy to receive the medal, then the treasurer of the Society would return to the treasurer of the trust company the amount of interest which may have accumulated during that year, that interest to be added to the principal of the fund.

Fifth. As the principal would thus increase gradually, the Society would be at liberty later to establish at its discretion two or more such prizes.

Sixth. If at any time the American Ophthalmological Society should give up or forfeit its certificate of incorporation, or should cease for more than three consecutive years to hold its annual meetings, then the principal sum now donated to that Society, with any interest which may have accrued and also any additional sum or sums which may have been added otherwise to the same fund, would thereupon become the property of the Section on Ophthalmology of the American Medical Association. And the treasurer of the Metropolitan Trust Company would be empowered to make the transfer of ownership from the American Ophthalmological Society to the American Medical Association to be used by its Section on Ophthalmology in the manner herein indicated.

Seventh. During the lifetime of the donor this prize medal may be called simply the "Medal for Research of the American Ophthalmological Society."

The donor appreciates that the amount thus offered is very small in comparison with some of the prize medal funds. He feels, however, that it is the duty of every one of us, certainly of every official, to leave the Society a little wiser or else a little better organized than he found it.

Possibly the example may be of some value if the medal itself is not; for, if a hard-working doctor recognizes the importance of research sufficiently to contribute to it a part of his slow earnings, then perhaps some grateful patient of one of our members may be moved to encourage vastly more the study which has given to each one of us his daily bread, his daily inspiration, and his lifelong joy.

Dr. G. E. de Schweinitz moved that the thanks of the Society be given to Dr. Howe through the proper channel for his very generous offer.

The motion was seconded and carried. Dr. Howe then resumed the Chair.

Dr. Woods said that he had been requested to state that the Council has received the most generous offer of the

President with heartfelt and sincere thanks. Dr. Howe replied that it was a very small affair, and he wished that the amount were larger.

The Report of the American Board for Ophthalmic Examinations was read by the Chairman, Dr. Edward Jackson:

Since the last report of the American Board for Ophthalmic Examinations, made each year, two meetings of the Board have been held, one in New London, Conn., in July, 1918, and one in Philadelphia, June 7, 1919. At the last meeting an examination of candidates for the certificate of the Board was held.

There has been some reference heard, at this meeting, to the Board as a "self-constituted Board," and it should be the duty of every member of this Society to dispel such ignorance when he gets a chance. It is well known that the Board is composed of nine members, three each from this Society, the Section on Ophthalmology of the American Medical Association, and the American Academy of Ophthalmology and Oto-laryngology. These members are elected by the different societies. The Board is therefore neither self-constituted nor self-perpetuating.

The American College of Surgeons has invited this Board to act as its Committee on Credentials for all candidates for Fellowship in the College who claim admission by virtue of being ophthalmic surgeons, or to be more accurate, the College has appointed a Committee on Credentials in Ophthalmology which is identical in personnel with the Board. The College further has assumed the burden of the office and clinical work of the Board, and put at its disposal all the information which it has about practitioners in the United States. At the same time the Board preserves its identity, individuality, and autonomy, and none of its functions are abridged or surrendered.

Since the Board was organized it has granted its certificate to about 135 ophthalmologists. In determining the question of certificates the question of the candidate's preliminary education and training is carefully investigated, together with his professional and ethical standing. He is required to submit to the Board the reports of twenty-five cases that he has

attended. These cases must represent a variety of conditions, and must not include more than ten cases of errors of refraction. An examination of these histories enables the Board to judge of how the candidate studies and records his cases, and is a most valuable guide to forming an estimate of his ability. The examination of the candidate consists of a practical oral examination and a written examination. The practical oral examination covers eight subjects, and in each subject two examiners usually participate. These subjects are:

I. Refraction, including retinoscopy, use of test case, and measurement of the error with the ophthalmoscope.

II. External diseases of the eye.

III. Muscular and binocular vision.

IV. Perimetry.

V. Ophthalmoscopy.

VI. Pathology.

VII. Therapeutics.

VIII. The relation of ophthalmology to general diseases.

This part of the examination is clinical, and carried out by means of patients. A proper relative value is assigned to each object, but at present the Board feels that a candidate should not pass unless he is proficient in the use of the ophthalmoscope, no matter how accomplished he is otherwise.

The remainder of the examination is written, and the following questions were the ones asked at the examination on June 7th.

1. Describe the development of the crystalline lens.

2. Draw a diagram of a vertical cross-section of the middle of the upper lid indicating the structures and their relation.

3. What changes take place in the iris in the act of accommodation, and what is their effect on vision.

4. Describe the repair of corneal tissue after its destruction by a corneal ulcer.

5. A patient with uveitis develops increased intraocular tension with severe pain and loss of vision. How would you manage the case?

The object of this report is to acquaint the members with the activities of the Board. Conditions during the past two years have interfered a good deal with its activities, but with

the help of each member of the societies who have created the Board, added to the efforts of the Board itself, the work will soon be better known and the purposes of the Board more completely fulfilled.

The next examination of the Board will be held in New York in October in connection with the Congress of the Clinical Surgeons of North America.

The Report was accepted and ordered printed in the Transactions.

The Chair appointed the following Committees:

Council: Drs. William Zentmayer, C. F. Clark, Cassius D. Wescott, Walter B. Lancaster, and Walter R. Parker.

Committee on Theses: Drs. William H. Wilmer, Howard F. Hansell, and George S. Derby.

Committee on Program: Drs. William T. Shoemaker, E. A. Shumway, and the Secretary.

Committee on Publication: Drs. William M. Sweet, Walter E. Lambert, and the Secretary.

Committee on Standardization of Illumination of Test Cards and Perimeters: Drs. William Zentmayer, Walter B. Lancaster, and H. Maxwell Langdon.

Representatives on the American Board for Ophthalmic Examinations: Dr. John E. Weeks, to serve for three years, Dr. Myles Standish, to serve for two years, and Dr. William Campbell Posey, to serve for one year.

The President announced the deaths of Drs. J. M. Ray, of Louisville; Richard Andrews Reeve, of Toronto, Canada, and W. F. Mittendorf, of New York. He then spoke as follows: In that connection, it seems appropriate to announce the death of the sons of two of our members and extend to them our sympathy in their sorrow. The son of Dr. M. L. Foster, of New Rochelle, N. Y., had risen to the rank of Captain, was in the Argonne, served well, and died. Another confrère, especially distinguished and beloved, Alexander Duane, served in another part of the field, near

the Cambrai sector, and met a similar fate. His detachment was ordered out, with about 175 men, but only a little over 30 reported the next day. No comment is necessary on that magnificent record.

I think we should rise, gentlemen, as a simple testimony of the sympathy we have for our colleagues who have been in affliction and sorrow.

Dr. Walter B. Lancaster presented the following resolution:

WHEREAS, A Year Book which gives a well-classified digest with indexes and cross-indexes of ophthalmic literature is absolutely necessary to every earnest student, and to the progress of our science, and

WHEREAS, It seems probable that we are to be deprived of the most complete work of that kind hitherto existing, and

WHEREAS, Our professional interests and national pride demand that ophthalmology shall not be allowed to degenerate because of this effect of the war, therefore be it

Resolved, That we hereby express our sense of obligation to Dr. Jackson and his colleagues for their efforts already made in this direction and approve the financial management of the Year Book. But we hope to see it enlarged and improved, and if at any time any member of this Society is asked to assist in the preparation of the Year Book, he hereby is urged to do so cheerfully, to the best of his ability and without hope of financial reward.

On motion, duly seconded, the resolution was adopted.

The following resolution, presented by Dr. John E. Weeks, was adopted:

It is the sense of the American Ophthalmological Society that the work of the Medical Research Laboratory, instituted at Mineola, L. I., should be continued. The investigations of the many problems still unsolved, and those questions that may arise in the future, will be of great value not only to aërial navigation, but to science itself. The work already done at this laboratory has been of great clinical, economic, and human value, and it has stimulated research

along lines hitherto sadly neglected. In addition to other lines of work, it has stimulated research in the physiology of vision, and this Society feels that it will have great influence upon the future teaching of ophthalmology in this country.

Therefore, be it resolved by the American Ophthalmological Society that the Surgeon-General of the United States Army be requested to make provision for the continuation of this laboratory.

Dr. G. E. de Schweinitz presented the following resolution, which was adopted:

WHEREAS, Meetings of the International Congress of Ophthalmology, affording as they do opportunities for an interchange of ideas and of ideals, have widened the scope of the individual ophthalmologist and thus indirectly benefited mankind, and

WHEREAS, The interruption of the St. Petersburg meeting has resulted in an interval now of ten years since the last Congress, and

WHEREAS, The leading position, economical and otherwise, which the United States now occupies makes it a moral duty for this nation to endeavor at least to lead in medical science also, therefore

Resolved, That a committee of three be appointed by the Chair to coöperate with similar committees from the American Medical Association and the American Academy of Ophthalmology and Oto-laryngology, and if such committees, acting jointly after consultation with our colleagues abroad, decide that it is desirable to hold the next International Congress of Ophthalmology in the United States, then that joint committee shall make suitable arrangements for the assembling of such a Congress, but be it further

Resolved, That neither this joint committee nor any part of it shall obligate financially the organizations which they represent without first reporting back to those organizations and obtaining further instructions from them.

The President appointed, as members of the committee thus provided for, Drs. G. E. de Schweinitz, W. H. Wilmer, and Fred. T. Tooke.

The Committee appointed at the last meeting of the Society to consider changes in the By-Laws, with the recommendations suggested by Dr. Lucien Howe, made its report. Dr. Hiram Woods, Chairman of the Committee, stated that a printed report had been sent to each member of the Society, according to the instructions given at the 1918 meeting.

Dr. Woods read the first amendment, as suggested by Dr. Howe and then as modified by the Committee, explaining the Committee's reasons for making these modifications. It was decided by the President that each amendment should be considered and voted on separately. Before a vote was taken it was found that there was not a quorum present.

After considerable discussion, a motion made by Dr. Edward Jackson, that the time for consideration of the amendments be fixed for the first Executive Session of the 1920 meeting, was carried.

Just before adjournment the President arose to receive the incoming President. In doing so he held a gavel made of black walnut, the cylinder of the gavel being inclosed with a silver band. The inscription on the band read as follows:

THE FIRST MEETING
FOR THE FORMATION OF THE
AMERICAN
OPHTHALMOLOGICAL
SOCIETY
WAS HELD JANUARY 9, 1864
AT THE OFFICE OF
DR. HENRY D. NOYES
NEW YORK
THIS GAVEL
WAS MADE FROM A CHAIR
IN HIS OFFICE
IT WAS USED AT
THE ANNUAL MEETING IN

Dr. Howe explained that, with the assistance of Dr. Weeks, of New York, and of a son of Dr. Noyes, he had obtained a fragment of an old chair or stool which had been in constant use in the office of Dr. Noyes for many years.

It seemed appropriate that some such relic should be preserved, and he therefore wished to present this to the Society to be kept always by the Secretary and used by the President at each meeting.

As evidence of this gift to the Society the gavel was handed to the incoming president, whom he welcomed cordially to the high office to which he had been elected, saying, that no greater honor could come to any member of our profession than to act as President of the American Ophthalmological Society.

TUESDAY, JUNE 17TH, 9.15 A. M.

Exhibition of New Instruments and Apparatus.

27. "German Field Optical Outfit." Allen Greenwood, M.D., Boston.

28. "Stereomicrometer —An Instrument of Precision for Measuring Stereopsis." Captain Harvey L. Howard, M.C., Mineola, L. I., N. Y.

29. "Six-Meter Stereoscope." Captain Harvey L. Howard, M.C., Mineola, L. I., N. Y.

30. "Visual Acuity at Low Illumination: Apparatus and Results." (By invitation) C. E. Ferree, Ph.D., and G. Rand, Ph.D., Bryn Mawr, Pa.

31. "Non-Operable Tumor of the Orbit and Brow Treated Successfully with Radium." George Huston Bell, M.D., and (by invitation) Sinclair Tousey, M.D., New York.

Discussed by Drs. Holloway, Clark, Lamb, Roy, Vail, and Bell.

32. "A Positive Focal Tuberculin Reaction in a Spindle-

Cell Sarcoma which had Perforated the Sclera." J. W. Charles, M.D., St. Louis.

33. "Clinical and Pathologic Report of a Case of Intra-ocular Tumor." Howard F. Hansell, M.D., Philadelphia.

34. "Two Cases of Epithelioma of Eyeball and Lids. Operation. No Return After Six Years." By Dunbar Roy, M.D., Atlanta, Ga.

Nos. 32, 33, and 34 discussed by Drs. Lamb, Veasey, May, Clark, Woods, Fiske, Wescott, Lamb, Heckel, Greenwood, Charles, Hansell, and Roy.

35. "Report of Three Additional Cases of Paralysis of Accommodation Due to Focal Infections." Clarence A. Veasey, M.D., Spokane, Washington.

Discussed by Drs. Hansell, Duane, Howe, Holloway, Woods, Worrell and de Schweinitz.

36. "Accommodation in the Lensless Eye, Occurring in a Woman Aged Seventy-three Years, Following Extraction of Cataract." A. Edward Davis, A.M., M.D., New York.

Discussed by Drs. Wescott, Clark, Zentmayer, Tarun, White, Harlan, Vail, Lambert, Jackson, and Davis.

Adjourned.

The following members were present and registered at the Fifty-fifth Annual Meeting:

Bailey, Fred. D.
Bedell, Arthur J.
Bell, Geo. H.
Bell, Jas. H.
Bordley, James, Jr.
Briggs, H. H.
Brown, E. V. L.
Bruner, Wm. E.
Butler, W. K.
Calhoun, F. Phinizy
Callan, L. W.
Callan, Peter A.
Carmalt, W. H.
Chance, Burton
Charles, J. W.
Clark, C. F.
Davis, A. E.
Dennis, David N.
Derby, George S.
Duane, Alexander
Duncan, J. L.
Ellett, E. C.
Fenton, T. H.
Fiske, George F.

Foster, M. L.
Fox, W. H.
Francis, Lee M.
Fridenberg, Percy
Goldberg, H. G.
Greene, L. S.
Greenwood, Allen
Griscom, J. Milton
Hansell, H. F.
Hardy, Wm. F.
Harlan, Herbert
Harrower, David
Heckel, Edw. B.
Heed, Chas. R.
Holloway, T. B.
Holmes, C. R.
Holt, E. E.
Howard, Harvey
Howe, Lucien
Jackson, Edward
Jameson, P. C.
Jervey, J. Wilkinson
Kennon, B. R.
Knapp, Arnold
Koller, Carl
Lamb, Robert S.
Lambert, W. E.
Lancaster, W. B.
Langdon, H. M.
Loring, R. G.
Lovell, D. B.
McGuire, Hunter H.
Macleish, A. L.
Marlow, F. W.
May, C. H.
Miles, H. S.
Ohly, John H.
Parker, W. R.
Posey, W. Campbell
Price, H. R.
Pyle, Walter L.
Quackenboss, Alex.
Radcliffe, McCluney
Reese, R. G.
Reik, H. O.
Reynolds, W. G.
Ring, G. O.
Roy, Dunbar
Sautter, A. C.
Schneideman, T. B.
de Schweinitz, G. E.
Shannon, C. E. G.
Shannon, John R.
Shoemaker, Wm. T.
Shumway, E. A.
Smith, Dorland
Smith, E. T.
Spratt, Chas. N.
Standish, Myles
Sutphen, T. Y.
Sweet, Wm. M.
Tarun, William
Taylor, Lewis H.
Theobald, Samuel
Tyson, H. H.
Vail, Derrick T.
Veasey, C. A.
Verhoeff, F. H.
Weeks, J. E.
Weidler, Walter B.
Wescott, C. D.
Wheeler, John M.
White, J. A.
Wilder, W. H.
Williams, Carl
Wilmer, Wm. H.
Woods, Hiram
Worrell, J. P.
Zentmayer, Wm.
Ziegler, S. Lewis

PRESIDENT'S ADDRESS.

On the Desirability of Enlarging the Ophthalmic Year Book.

Although it is not customary in this Society for the president to deliver an address at the opening of the session, I venture to ask your attention to a subject which, just at present, seems of vital importance to ophthalmology. That subject is the desirability of enlarging the Ophthalmic Year Book. The reasons for this can be seen by considering —

1. The relative value of a Year Book. 2. What our present Year Book is. 3. How it compares with the Jahresbericht. 4. Why the Year Book should supplant the Jahresbericht. 5. How that can be done.

1. The Relative Value of a Year Book.—It is evident that the progress of any branch of science depends on the discovery of new facts and the dissemination of knowledge concerning them. It is also well known that a large part of what we read or hear concerning ophthalmology and other branches of medicine consists of familiar facts which already have been published. This repetition is not usually due to a desire on the part of the writer or speaker to plagiarize, but to ignorance of what is already on record. That ignorance is due to the fact that the writer or speaker did not have, or did not refer to, the Year Book or to some similar index of the literature.

It is then obvious that a digest, properly indexed and cross-indexed, is not only convenient, but a necessity as necessary to the ophthalmologist as a Bradstreet is to a bank or a dictionary to a library. Such a Year Book, as the

key to our ophthalmic knowledge, is the one most valuable volume a student or practitioner can possess.

2. The value of our present Ophthalmic Year Book can be shown best by figures. The contents of the volumes for 1912 and 1918 are given in the first two columns of the following table:

	YEAR BOOK, 1912	YEAR BOOK, 1918	JAHRES-BERICHT, 1912
Collaborators	10	52(?)	18
Number of titles of papers (about)	2170	2040	3550
Divisions and subdivisions	33	29	61
Number of abstracts (about)	2100	2000	2650
Number of subjects indexed (about)	1200	1150	1450
Pages for abstracts	436	254	1122
Pages for bibliography	73	34	166
Pages for index of names	9	9	20
Total number of pages	518	297	1308

The columns show first that, although the number of collaborators has apparently increased, the number of articles collected by them has decreased; second, the number of abstracts made from these articles has also lessened; third, there has been a similar decline in other features of the Year Book, and its size in 1918 is less than in 1912.

But in spite of the decrease it is none the less true that the Year Book is by far the best index and digest of ophthalmic literature in any language except German. It is impossible to overestimate the energy, the care and sacrifice which have combined to produce this result. It has been accomplished, as we all know, by a small group of men, principally residents in Denver, under the leadership of one man—Edward Jackson.

3. How does our Year Book compare with that of Germany? The full name of the latter is *Jahresbericht über die Leistungen und Fortschritte im Gebiete der Ophthalmologie.* But we all know it as "Nagle," or as the "Jahresbericht."

The Year Book of 1912 is here compared with the Jahresbericht for the same year. The volume of the latter for 1913 was prepared in the earlier half of 1914, and was incomplete because of the breaking out of the war. As the data relating to these two volumes for the same year are arranged in parallel columns, a comparison is easy. No comment is necessary. Adherence to truth seems to force us to the rather reluctant conclusion that a relatively small group in Germany, who are primarily students, obtained better results than our larger group, who are primarily clinicians. But important events have occurred since this was published. The Jahresbericht has apparently gone out of existence. It was reduced in size by even a few months of the war, and in spite of persistent inquiries it cannot be obtained. It could be revived only with great difficulty, and even if it were its circulation in the allied countries would be much curtailed.

4. Why the Year Book should supplant the Jahresbericht: First, for our own sake. Instead of permitting the Year Book to decrease in size or show any sign of decay, it should wax stronger and become more complete. This should be done not only for English-speaking ophthalmologists, but for others as well.

Second, for our national pride. If the Year Book does not promptly supplant the Jahresbericht, the failure to do so will constitute a tacit admission that in this department, at least, Americans cannot equal the Teutons. It would mean that our gain in war resulted in a loss to science.

5. How can the Year Book supplant the Jahresbericht? In order to do this we need a change of plan and then two things—men and money. Both of these are probably available, at least for a beginning.

As to change of plan, the Year Book should be separated from the Journal, not financially, but in form. It should not be published in detached portions, as at present, but as

a single separate volume containing all the ophthalmic literature of the previous year. Although the digests given monthly are entertaining to the casual reader, the student certainly prefers the more complete and systematic arrangement of all the articles which appeared in a given year, as is found in the Jahresbericht.

As to the collaborators, as little change as possible should be made in the present editorial staff. To Dr. Jackson and his associates belong the credit of maintaining the present Year Book. With this small group of leaders should be men who, severally, would pledge themselves to work out thoroughly the small parts assigned to each. The collaborators should not attempt to cover so large a field as at present. The editorial staff should divide the work, subdivide it, and subdivide it again. No one man could read all the articles on the uvea, for example, and make a digest of them. In 1912 the Jahresbericht gave 187 titles on different aspects of that structure. That year it was dealt with in the Year Book in one section, presumably by one man, in one article of 14 pages.

The collaborators should not be chosen so largely from the United States. They should come from our colleagues in all parts of the world. The selection would not be difficult if only men were invited who have already distinguished themselves by investigation of a certain phase of a single subject. A choice on this basis would insure the interest of that individual or group in that subject. When such a collaborator becomes known as identified with a special subject, we would all send to him our reprints on that topic with the hope that they would receive proper notice. He in turn would be able to accomplish more for ophthalmology and for his own reputation. The distribution of the work among collaborators of different countries would also bring the Year Book to the notice of other foreign colleagues and thus add other names to the list of subscribers. Above all, by

thus giving to each collaborator a very small phase of a small subject, and limiting his report to only a few pages each year, the work of collecting articles and reviewing them would change from a form of drudgery to delightful recreation. If this Society would unanimously resolve to assist the editors of the Year Book in their work, this desideratum would be assured.

Finally, as to the cost: The presumption is in favor of financial success. If the Jahresbericht was self-supporting before the war, it is probable that the Year Book would be now. Figures also indicate that such a publication could be made self-supporting.

One of the leading publishers of medical books in this country has estimated that an edition of 1000 volumes like the Jahresbericht for 1912 could be produced (unbound), even at the present exorbitant prices of paper and labor, for about $4500. It is difficult to separate entirely the present cost of the Year Book from the total cost of our *Journal of Ophthalmology*, but similar rough estimates have placed the cost of the former at not far from those figures, namely, $4500. So it seems probable that, with proper adjustment, the financial demands could be met.

In conclusion, we find—

1. A first-rate Ophthalmic Year Book is a necessity to the progress of our science.

2. Our present Year Book is the best in any language except German.

3. It still falls far short of what the Jahresbericht was.

4. The Year Book should supplant the Jahresbericht, (*a*) for our own sake, professionally; (*b*) for our own credit as American students; (*c*) as other nations have lost so many more lives and are so much more impoverished than we, it should be our pride to take up this burden and to bear it becomingly.

5. That can be done. Besides a change, probably neces-

sary, in the present form of the Year Book, its editors need more ready and earnest literary coöperation by members of this Society and by other ophthalmologists. Also, it may be necessary, for financial reasons, to modify the Journal, or the present Year Book, or both. But the difficulties can be overcome.

Before the war Germany was, rightly or wrongly, considered the Mecca of medical science, especially of ophthalmology. Now that Mecca is ruined, at least financially. Ophthalmologists of the world look to us to supply what has been lost. They ask what can really be done for our science by a group of men in a company of restricted membership? Thus circumstances bring the American Ophthalmological Society to the front. A call comes to each of us, and I should be recreant to the trust resposed in me if I did not repeat that call in uncertain tones. The usual formality following a president's address is for some one to move the perfunctory vote of thanks and the appointment of a committee to report on the recommendation. The thanks may be omitted; but I do ask that in executive session a resolution be passed which shall encourage the earnest work of the few who have given us our only English Year Book, and which shall urge the personal effort of you, of me, of every ophthalmologist, to make ours the best in any land.*

* Such a resolution was unanimously adopted in the executive session.

REQUIREMENTS AND EXPERIENCES IN OCULAR EXAMINATIONS FOR THE ARMY.

WILLIAM H. WILDER, M.D.,
Chicago.

Both the mental and physical requirements for military service have changed with the times. Formerly, when every soldier was regarded as a fighting man, he was required to have a physical condition as nearly perfect as possible to withstand the strain of the fierce game of war. Naturally, there went with this the idea that his vision also should be perfect, and such an ideal standard is still maintained by certain military authorities, to be required whenever possible.

But in modern armies every soldier is not expected to be a fighting man; that is, to be on the firing line, although it is not too much to expect or demand that he shall have the fighting spirit.

Hence, very wisely, the rigid requirements of vision that were formerly in vogue have been modified to suit the needs of the different branches of military service.

With the demand for a vastly increased army, with its variously differentiated functions, it was evident that requirements for military service would need still further modifications, and these were announced in the Standards of Physical Examinations governing entrance to all branches of the armies of the United States issued by the President under the terms of the Selective Service Law of May, 1917.

These standards, as finally revised in Form 75, issued through the Provost Marshal General's Office, provide that a registrant is to be accepted for general military service with a minimum vision of 20/100 in one eye and 20/40 in the other

eye without glasses; or 20 100 in each eye without glasses if correctable with glasses to 20/40 in either eye.

The registrant was acceptable for special and limited military service with: (*a*) 20 200 in one eye and 20 40 in the other, either right or left, without glasses, or 20 200 in each eye without glasses if correctable with glasses to 20 40 in either eye. (*b*) Blindness in one eye with normal vision in the other eye without glasses.

There was no qualification stated as to the degree of blindness, and it was to be inferred that one eyeball might be absent if the other had normal vision.

In contrast with our requirements the Wartime Standards of the British army considered the man fit for any military service who had 20 80 in one eye correctable to 20 40, even if the other eye had only sufficient vision to count fingers or to enable him to get about. However, the British regulations provided that all men whose vision was less than 20 40 must be examined by the eye specialist, a very wise rule.

The British standards also placed men for garrison service overseas who have correctable vision of 20/40 in the right eye (if the condition is myopia, it must not exceed 7.50 diopters), and any vision at all in the left eye, or even nothing, if there is no active organic disease.

These more liberal standards allow the acceptance to the service of men who have in one eye a condition we call congenital amblyopia. To quote from an article read before the Section on Ophthalmology at the Annual Session of the American Medical Association, Chicago, June, 1918:

"Any one who has carefully examined many eye cases in the clinic, or for the advisory board, or for the review board at one of the cantonments, must have been struck by the frequency of this condition, the degree of amblyopia varying from the ability to recognize forms or to count fingers up to 20/200 or better.

"The simplest tests show that the man is not malingering,

and a careful ophthalmoscopic examination fails to reveal any deviation from the normal. On inquiry one frequently gets the history that the poor vision of one eye was not discovered until some trifling incident or circumstance prompted him to close the good eye, and an examination later by a physician showed the degree of the defect.

"Such cases, provided there is no fundus lesion observable, show a practically normal form field and good fields for color, showing that only the central vision is affected. Such persons are seldom annoyed by asthenopia if the fellow-eye has fairly good vision and no great refractive error, for they do not have binocular single vision.

"Such men, if otherwise physically fit, should certainly be accepted for special or limited military service, if not for general service; many of them are engaged in occupations requiring good sight."

This brings up the subject of the importance of having trained ophthalmologists on any board that has to do with examining recruits for the army and of having such trained specialists regularly in the service. The services of such an expert are necessary to determine whether it is safe to accept a man with a limited degree of vision, for many a man with a considerable visual defect will make a better soldier than one whose vision comes well within the requirements, but might have asthenopia and who would be passed by the ordinary examiner who has no special knowledge of ophthalmology. Too much praise cannot be accorded that unselfish group of ophthalmologists who successfully fought for the recognition of ophthalmology as a necessary part of the military régime. The medical history of the war will show the value of their work.

Standards for Officers and Enlisted Men.—Formerly the idea obtained, and to a great extent still persists, that an officer should be a superior being to the enlisted man, physically as well as mentally—a sort of superman. This idea still holds in the requirements for the cadets in our military and naval

academies, and even in the exigencies of war time, when requirements and standards have to be made so much more elastic, we can see that this idea still governs and results in certain rather glaring inconsistencies. For example, in some branches of the service the requirements are the same for officers and men as in those for the Line and Signal Corps, where 20 40 in the right and 20 100 in the left without correction is necessary.

In the hospital corps the same requirement is made for the men as for those in the Ordnance Corps and for Army Field Clerks, viz., 20 70 in each eye correctable to 20 40; but officers of the Medical Corps are required to have vision corrected to 20 20 in each.

It would seem that men could be safely admitted to the Ordnance and Hospital Corps with lower vision than 20 70 correctable to 20 40, and the requirements for medical officers should be no more rigid than for the men under them.

The enforcement of this rigid requirement in the early days of the war resulted in the rejection of many medical officers otherwise well qualified, but later much more latitude was given the examiners, and waivers of considerable defects of vision were allowed.

Indeed, a medical officer with a myopia that reduced his vision to 10 200 correctable to 20 40 in each eye might be perfectly able to perform the duties pertaining to his position, and would not be seriously handicapped by his defect—certainly not more so than his men.

Incapacitating Conditions.—The last instructions issued to the Local Boards and the Medical Advisory Boards from the Office of the Provost Marshal General in Form 75 ordered the unconditional rejection for all military service of those registrants in the draft who had any of the following defects:

(*a*) Total blindness. (*b*) Vision less than the minimum requirements for special and limited military service. (*c*) Disfiguring cicatrices of the eyes. (*d*) Lagophthalmos. (*e*) Pro-

nounced exophthalmos. (*f*) Chronic keratitis. (*g*) Chronic recurrent inflammatory diseases of the globe. (*h*) Deep ulcer of the cornea. (*i*) Any organic disease of the retina, choroid, or optic nerve. (*j*) Detachment of the retina. (*k*) Marked nystagmus. (*l*) Loss or disorganization of either eye with less than normal vision in remaining eye. (*m*) Glaucoma. (*n*) Diplopia, due to paralysis of the extrinsic ocular muscle. (*o*) Abnormal condition of eyes due to diseases of the brain. (*p*) Malignant tumor of lids or eyeballs. (*q*) Trachoma.

It was a matter of comment that there was omitted from this list of disqualifying conditions one that had appeared in previous manuals of instructions to local and medical advisory boards, viz., opacities of the lens or its capsule sufficient to reduce the vision below the standard, and progressive cataract of any degree. It is the supposition that this was an oversight.

The wisdom of the advisers of the Provost Marshal General is shown in placing trachoma in the list of causes for unconditional rejection, rather than in that which accepted the registrant for general military service in the deferred remediable group as it appeared in the early Manual of Instructions for Medical Advisory Boards.

While we all recognize that trachoma is not a virulently contagious disease, yet the past history of military campaigns has shown that it may become a serious epidemic in the conditions that obtain in the camp and in the field.

It was far wiser, therefore, as there was so much good material to select from, to exclude any case of trachoma that might be contagious at the time or later might become so.

At Camp Zachary Taylor, Louisville, Ky., which drew men for the first and second drafts from Kentucky, Indiana, and southern Illinois, in which region there is considerable trachoma, there were rejected by the Review Board about 300 registrants because of this disease. It is true some of these—not a large percentage—were doubtful or debatable

cases, but as facilities were not at hand to keep them for four or six weeks until careful treatment would establish the diagnosis, it was deemed wise to send them home and have the local boards put men with healthy eyes in their places.

In this connection it seems proper to mention that the fact was pretty well demonstrated that the average medical man is not able to recognize trachoma if he sees it.

Observations on Malingering.—Probably at no time in the history of this country have physicians been confronted with the problem of differentiating real from feigned conditions to the same extent as has presented in the last two years.

Ophthalmologists in this country had had little experience in detecting malingering as compared with their colleagues in foreign countries in which military service was compulsory. Now and then the surgeon, neurologist, or eye and ear specialist would have an opportunity to pit his skill and wits against some pretender who claimed indemnity for alleged injury received from some industrial corporation, railroad, or municipality that he was privileged to sue for damages. But it required the principle of enforced military service by the general draft to bring out cases of this phase of human nature in any numbers, and it was really remarkable, after all, how comparatively small was the number of instances of malingering.

However, the provocation for the slacker was there, and the medical examiner had to be constantly on the alert in order not to slight the cause of the government and the country, on the one hand, or to do injustice to the drafted man, on the other.

There was little danger of the volunteer soldier attempting malingering. He usually stood so erect as to incline backward, and instances were known where some young zealous officers in training camps secured from the optical stores all the different vision charts they could procure and memorized them perfectly, as they would an algebraic or chemical form-

ula, and thought they were prepared for any visual test. It seemed a pity to confound such a spirit.

One day there came before the Review Board at Camp Zachary Taylor a young man of good physique, alert, quick witted, and very desirous of getting into military service. When placed before the chart, he promptly showed normal sight in each eye, but the examination revealed an artificial eye so well matched as to be able to deceive even a medical student. So far as I know, this is the only case on record of a glass eye with 20/20 vision, for so the Local Board Examiner had reported him.

Another man in that camp wearing an artificial eye, and also desirous of serving his country, managed to evade the regimental surgeons and it was several weeks before he was discovered. Such cases spoke more loudly for the patriotism of American youth than for the professional attainments of some of the Local Examining Boards.

The medical advisers of the Provost Marshal General wisely foresaw the possibilities of the situation, and in the Manual of Instructions for Medical Advisory Boards prepared by a board of qualified specialists and military surgeons, appointed by the Surgeon General, very excellent and complete methods and tests for the detection of malingering were published. These rules were based upon the same rules and standards that were followed by the military examining surgeons at cantonments and recruiting stations.

It is hardly necessary, in this connection, to describe the various tests that were so excellently presented in this Manual of Instructions, and with which, doubtless, you are familiar, but it might be profitable to compare the practicability and relative value of some of them.

In the class of cases in which total loss of vision in one eye was claimed, one of the prism tests, or the reading test with a ruler placed between the eyes at a distance of four or five inches, would frequently expose the fraud.

But it was not sufficient that the examiner prove that the alleged blind eye had vision, he must also determine the degree of vision if possible.

For this purpose the red and green letters of Snellen were found valuable, with red and green glasses placed before the eyes of the subject. But in this test it is necessary that the red should cut out all the green rays, and vice versa, or a wrong result will be obtained that might work an injustice to the registrant. Unfortunately, owing to the hurry of preparation and the difficulty in securing the right shades of colored glass very imperfect colored letters were furnished by the Government to many of the Advisory Boards and cantonments. I have frequently found, on comparing results obtained with such faulty equipment, with those obtained with reliable colored letters and accurately neutralizing colored glasses and with other tests, that inaccuracies occurred that operated to the discredit of the man examined.

A very valuable test, not mentioned in the Manual of Instructions, was found applicable in cases that claimed much lowered vision in one eye, as also in those who claimed blindness in one eye, and were convinced by the well-known prism tests that, after all, they had some sight and could see large objects.

This test consists in placing before one eye, say the good one, a 12° or 15° prism base down. At 20 feet distance this will cause the subject to see two distinct charts of ordinary size, one above the other, and he is asked to read the letters alternately from one or the other, and in this way the vision of the alleged amblyopic eye is obtained with approximate correctness.

The test can be varied by placing the prism before one eye or the other with base up or down. In conjunction with the stereoscopic test it was found to be very useful and a time-saver.

Many of the men who attempted malingering were of

inferior education and many of inferior intelligence. As wisely stated in the Manual of Instructions, "there is something definable in the bearing of the malingerer which experience alone can detect. He may be self-assertive and overconfident; he may be hesitating or evasive. His detection is more likely to result when he is allowed to believe that his case is regarded from the first as genuine and that his story is not discredited."

It might have added that he is often sullen and obstinate, as if from a dread that his deception will be discovered.

Many of them had evidently been imperfectly "coached" on the visual requirements for the soldier, and had been told that under no circumstances must they read more than the top letter on the chart, and to this they persistently adhered regardless of the distance they were from it.

It was a simple matter to hinge the chart and turn back the large letters so that the top would be 20 100 or 20 70 or 20/40 as desired.

This would suggest the advisability of some form of cabinet in which the letters could be easily and quickly changed, but, of course, the time was too short to prepare such equipment in the great numbers required.

The most difficult case in which to determine the degree of the vision is the man who alleges that both eyes are very poor and who persistently refuses to see anything on the chart with either eye at any distance. It may be perfectly evident from his behavior, and the way he walks, that he can see and see well. He may have hung his hat on a nail promptly when told to do so, at the beginning of the examination, but he refuses to recognize coins and small objects and peers around in a searching way that is evidently intended to deceive. When made to walk in bare feet over a ward floor strewn with small objects like blocks of wood or nails, it is plain that he sees well enough to avoid them. The ophthalmoscope may show nothing abnormal or only a slight

refractive error. That such a person is malingering is quite evident, but I know of no test that will, with any degree of accuracy, show his visual acuity.

The detection of malingering was one of the interesting features of what was, for the most part, a rather dull and monotonous work of the ophthalmologist on the Advisory Board or the Review Board of a cantonment. But one could not avoid the thought, at times, that it was not worth while to force these malingerers into the army.

Most of them would not admit their attempt to deceive, but that is human nature. If they were sent to camp, some might reform, but most of them would be shirkers, trying at every opportunity to get sick leave, disturbing the morale of other weak soldiers, and making themselves a general nuisance until they were courtmartialed or dishonorably discharged.

DISCUSSION.

DR. E. C. ELLETT, Memphis: All of us who have had to do with the work done in the camps must have marveled at the sort of men that occasionally got in. I saw one man brought in on a stretcher, with a shortening of four inches in one femur and eversion, so that he could not walk a step; yet he had been admitted into the army for front line military service. One man came with his brother. I asked why the brother was there, and he said that the man who had been drafted was mentally deficient, so that the family never allowed him to go about without an attendant. I think that the way in which these things happened was that the men were summoned to appear before a draft board; and, if they did not do so, they were summarily put into the service. I saw another man, a non-commissioned officer, recommended to be sent to a training camp for officers, who, when examined was found to have an artificial eye. He had progressed that far in his military career without this having been discovered. The camp that I was in had a Board that worked most efficiently. It was composed of men doing special work of all sorts. The men who came to camp went before that Board. I do not know whether that was the habit in other camps, but it was a most satisfactory

arrangement. Every man whose hearing or vision was not normal was immediately referred to the proper specialist on the Board for more complete examination.

DR. ALLEN GREENWOOD, Boston: I desire to discuss the paper from the standpoint of reclassification, which was one of the problems that came before the consulting ophthalmologists in France, and to call your attention to the paper which I read before the Section on Ophthalmology of the American Medical Association where there is an abstract of the reclassification that we found in France on our arrival there, and which had proved difficult for the ophthalmologists to interpret. On the page, where you find the recommended and adopted new reclassification, you will see it stated that this reclassification was the subject of a great deal of thought on the part of Drs. Black and Derby and myself. Dr. Derby, in view of his service with the British, and knowing their reclassification, was particularly helpful, as was the reclassification Colonel Parker had worked out in the Surgeon General's Office. Actual experience has proved that our overseas reclassification covers the ground well.

DR. WILLIAM H. WILDER, Chicago: My paper makes mention of one test for malingerers, with which many of you are probably familiar, which proved to be very useful, but was not described in the "Instructions for Examining Boards." A prism of twelve or fifteen degrees, apex up or down placed before one eye will cause the individual to see two charts one above the other at the customary distance of twenty feet, if he has vision in each eye. If now he can be persuaded to read the chart that corresponds to the alleged blind or defective eye, we may not only prove that the eye has vision, but also may determine at once the actual acuity of that vision. The test may be varied, by placing the prism first before one eye and then before the other. This was found to be more accurate than the test with the colored letters furnished by the Department, as the reds and greens did not neutralize. As stated in the paper, I know no test that will determine the degree of vision of the man who persistently refuses to read any letters on the chart with either eye. One may be satisfied that he can see fairly well, but it is another matter to prove it.

THE EYES OF THE SIGNALMAN.

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New York.

The relation of ophthalmology to naval signaling may be studied under two aspects:

1. What are the visual qualities required in order to carry on the delicate and important work of signaling at sea?

2. What is the reaction of the eye to work of this sort, *i. e.*, what pathologic effects may result from the visual strain involved?

Only the first of these questions will be considered here. I have never observed any untoward results on the eye functions from signaling. If such occur, I think they must be rare.

To answer either question intelligently, we must consider:

1. The character of the work to be done; *i. e.*, the types and methods of signaling employed.

2. The conditions under which the work is done.

3. The consequent demands made on the separate functions of the visual apparatus and the nervous system.

Types and Methods of Signaling Used.—The main methods used in naval signaling to-day are:

1. Flag hoist. 2. The hand semaphore. 3. Flashlight (blinker and searchlight).

Other methods, like the Ardois, the wigwag, the Very system, the machine semaphore, and signaling by shapes, are either disused altogether or are used so rarely as not to require any special consideration.

To the requirements involved in these forms of signaling must be added those demanded by other duties of men on the bridge, including their work as lookouts.

Flag Hoist.—The flags used in the navy are the following:

1. International flags, 27 in number. Used both in international and navy signaling, but by entirely different codes, with both of which the signalman must be familiar. (I may point out that our men were also taught the English code, in which the same flags are used with still a different meaning.)

2. Special navy signal flags, 16 in number.

3. Personal flags, from the President's flag down to the commission pennant (captain's flag), and distinguishing flags of different branches of the service (coast guard, army transport, etc.). There are some 42 of these; or, including foreign ones, at least 60.

4. Ensigns and jacks of the United States and other nations. There are a great many of these, but 30 are commonly seen.

5. Call flags and call pennants—46 in number.

6. Special English signal flags, numbering 35.

In other words, a man on the bridge has to be able to recognize and know the meaning of more than 200 different kinds of flags, of which 125 are in very frequent use.

The flags differ in shape and in color. In shape they are either square or oblong, called then collectively square flags, or simply flags; swallow-tailed (burgees); or triangular (pennants). The last are either very elongated, as in the commission pennant; moderately acute (twice or three times as long as broad); or equilateral, as in the senior officer's pennant. The colors found in flags are white, black, red, blue, yellow, and green. The last is rare, being found in only one signal flag and in the ensigns of Italy, Portugal, Mexico, Bolivia, and Brazil. Black occurs in three international and a few English signal flags and in the ensigns of Belgium, China, and the defunct central empires. The yellow used is a sort of mustard or sometimes a sulphur color, the red is the hue of the stripes in the American ensign or darker, the

blue in American flags is the dark navy blue, in French flags a lighter blue and therefore much more conspicuous.

The shape of a flag can be made out much further than can its color, and may by itself serve to distinguish the signal. Thus a burgee flying on an American man-of-war or merchant vessel must be either the international A or B, and, as the latter is a solid dark color (red) and the former a combination of light and dark (white and blue), it is easy to tell which flag it is, even if the actual colors in each cannot be distinguished. So, too, it is always easy to make out the commission pennant, because no other flag has its whip-like shape.

If, however, a flag is fouled or is flapping a good deal, it may be hard to tell its shape, and then flags, otherwise alike, international E and T, international G and K, may be mistaken for each other.

Another help in distinguishing the flag is its situation. Thus a flag flying at the flag-staff at the stern must be the ensign, and if it has another flag above it in the same hoist, the latter must be the church pennant; a dark flag flying in the bow must be a jack, while a dark flag at the main truck must be the personal flag of a rear admiral or superior dignitary (vice admiral, admiral, Secretary of the Navy, President); a dark pennant flying at the port forward yardarm must be the meal pennant, while one flying at the after starboard yardarm along with a commission pennant at the truck must be the flag of the senior officer present.

But with all these helps the main thing, after all, by which we distinguish the flags from each other is their color. In this respect they leave much to be desired. This is partly due to the impossibility of making up different sufficiently distinctive color patterns for all the 200 or more flags used; but it is also due to poor choice of hues. The reds, brilliant at first, become too dark when the flags grow dingy, as they soon do; and in American flags, even when new, the blue is

much too dark. Both colors, especially the blue, contrast but little with a mixed background (military mast, smoke-pipes, or land); and the blue at a little distance looks black and is often hard to make out at all. To see how the hue we use interferes with visibility, we have only to contrast American and French admiral's flags flying on neighboring ships. The light blue of the French is distinguished as a color twice as far as the dark blue of the American; and the flag itself is seen further as a flag, because contrasting better with the average background.

On the other hand, the yellows used are sometimes either too light or not sufficiently saturated, so that against a sun-lit sky they look white and are not very clearly distinguishable.

The poor coloration is particularly noticeable in our call pennants, which are used for calling individual ships to receive a message. These are made up of blue, red, and yellow bands, arranged to denote letters by the dot and dash code (red representing a dot, yellow a dash, and blue repeating the color immediately preceding). The blue is too dark, the blue and red, when in juxtaposition, afford too little contrast, and sometimes the yellow is too light. If the blue were decidedly lighter, the red had more yellow in it, and the yellow were always made sufficiently saturated, the pennants would be much easier to read.

Flag signals are intended to be hoisted rapidly and read instantaneously. The ability to read them instantaneously is absolutely essential in battle signals and in all manœuvers; hence the men are drilled to vie with one another in making, reading, and answering such signals with the greatest possible speed. And even in ordinary work it is highly important to be able to recognize the flags quickly at a distance. For example, when a warship comes into port it flies its identifying flags or "call" (international, naval, or both) and usually another signal, which requires immediate

answer, such as the four flag hoist meaning "May I anchor in berth assigned?" The signalman on the flagship must be quick to read all these flags, so as to identify the incomer, and, in the few minutes before it can reach its berth, report it and hoist the "Permission granted" signal.

With rare exceptions messages sent by flag hoist are code messages; *i. e.*, each hoist denotes a word, phrase, or entire message.

Semaphore.—In the hand semaphore, of which the machine semaphore, still used by the English, is a variant, the words of a message are spelled out, each separate letter being indicated by a special position of the arms, extended at a particular angle. Thirty different positions must be distinguished. Ordinary messages are sent at the rate of 18 to 20 words a minute, but a man has to be able to read at the rate of 25 words a minute, and the practised hands can read 30 words a minute or more. We derive our semaphore from the English, who are pastmasters at it. The French also have a hand semaphore differing from ours, and, indeed, better in some respects, being more legible and easier to make.*

In the wigwag, whose use is also practically confined to sending spelling messages, each successive motion denotes, not an individual letter, as in semaphore, but one of the dot and dash elements composing a letter according to the international Morse system. It consists simply in swinging a staff with a flag on the end either right, left, or straight forward from the vertical position, a right swing denoting a dot, a left swing a dash, and one to the front an interval. As it takes, on an average, three motions to make a letter, and as the motions themselves cannot be made as fast as the changes of position in the semaphore, wigwag is about five

* The Dutch have still another variety. The Chilean flagship which we were in communication with understood the English semaphore, the messages themselves being sent in Spanish.

times as slow as the latter. On the other hand, it is much more legible, since it is obviously a good deal easier to tell simply whether a movement is being made to the right or the left than it is to make out one of 30 possible positions of the extended arms held for a fraction of a second. Hence the wigwag is used in landing parties or under other conditions when the distance is too great for semaphore and the searchlight cannot be employed.

A very effective means of using wigwag is by torch or electric hand lamp. This is a very clear method of signaling at night when a searchlight is not available.

Searchlight.—This, in the form either of the powerful searchlight, the flashlights on the yardarm (yardarm blinker), or the hand-held blinker tubes, is the regular method of signaling by night and is getting to be more and more used in the daytime also. The light is interrupted either by a make-and-break key in the circuit or by a shutter, and long and short flashes, corresponding to the dots and dashes of the continental Morse code, are thus made. The code and method are common to all nations, and we have repeatedly signaled by this means to French and Chilean, as well as to English and American ships.

This method has the great advantage over the others that signals sent by it can be read very much further and are not as much affected by weather conditions. It is, however, the most difficult of all methods, and proficiency in it is secured only by long and steady practice. It demands close concentration of sight and mind and undivided attention. Practice during the first weeks is attended with visual and mental fatigue, so that the sight blurs and the mind wanders. With most persons this difficulty passes in time, although men vary extremely in the rapidity with which they learn. Some few, mainly, it would appear, from lack of concentration, never get to be good searchlight readers, although they do well enough at the easier semaphore. In some of these

cases it is possible that a refractive or muscular error has something to do with the disability, but my observations incline me to believe that it is due rather to mental inertness or nervous instability.

Lookout Duties.—The man on the bridge is supposed to keep constant lookout. Although the navy now divides quartermasters' duties, so that the ship's quartermaster does lookout work and the signal quartermaster confines himself to signals, yet in many cases the signal quartermaster has to attend to both. In any case he has to be capable of attending to both. He must then, under all conditions of weather and visibility, make out, and make out at a distance, so as to report promptly, the rigs and distinguishing marks of all sorts of craft from a battleship to a motor launch, the insignia or flags that they carry, the various kinds of lights and shapes borne by ships to indicate what they are and what they are doing, and a great number of other things requiring mental alertness and quick and keen eyesight.

Conditions Which Affect the Seeing of Signals.—Even in good weather and with a clear atmosphere signal work often makes high demands on a man's attention, his acuity and tenacity of vision, and his nerve control. A signalman must be able to keep his attention concentrated and his eyes glued on the sender, no matter what interruptions or distractions may occur, and particularly must not lose his head if a word or symbol escapes him here and there. The tyro, no matter how well drilled, is apt to get excited when he is first put at doing real work on the bridge. If he misses a word, he goes to pieces and loses the whole message. Or his attention flags and he gets into a sort of daze, so that the symbols, especially the quickly alternating flashes of the searchlight, fail to make any impression on his mind. All this is due, of course, rather to lack of mental control than to real visual disability. Yet visual defects also play a part, either by

making the signal so indistinct that it cannot be read at all or by making it so hard to see that the attention is strained to the utmost and gives out even sooner than it ordinarily would.

Quite the same is true of attendant conditions that make the perception of signals difficult. The conditions, then, that affect the perception of signals and which impose strain on the eye may be divided into, first, those that concern the visibility of the signals themselves; second, those that concern the visual ability of the receiver.

Conditions Affecting the Visibility of Signals.—1. Distance.—The maximum distance at which signals can be seen varies greatly with the method used, with the conditions under which the signal is seen (illumination, state of atmosphere, background), and with the experience and visual ability of the receiver. The maximum distances at which a man with good sight and working under favorable conditions can read signals with the naked eye is for semaphore one-third to one-half mile; wigwag, one to two miles (depending on size of flag used); wigwag torch, two to four miles or more; flag hoist (with large battleship flags), half a mile (more for some flags);* blinker light, three or four miles; searchlight, practically any distance.

For flag hoists, wigwag, and semaphore these distances may be doubled or even tripled by the use of binoculars or telescopes, provided the weather and other conditions are such as to render these aids available. Binoculars do not in general help in distinguishing blinker or searchlight, ex-

* Theoretically, flag signals should be seen twice as far as this, and semaphore half as far again. But, owing to the fact that under the best of working conditions the semaphore background is not ideal and that flags are never blown out perfectly straight nor against a properly contrasting background, the distances are about as stated.

I may add that very erroneous statements are made in this regard, especially by men in the service. Misled by them, I made some gross exaggerations in my article on Sight and Signaling in Navy, read before the American Philosophical Society.

cept occasionally in the daytime when the flashes are drowned out by excess of surrounding light.

Distance affects not only the definition of form, but also the distinction of color—the blues tending to look darker and ultimately black, and yellows lighter and ultimately white.

The attempt to read signals at maximum distance requires, of course, strict attention, and, if maintained for any time, may strain the visual power to the point where it gives out.

2. Illumination and Background.—For semaphore, wigwag, and flag hoist bright daylight with the sun shining on the object and a clear all-round sky background make the ideal conditions. Seldom are these attainable. The light is often poor. When it diminishes greatly, both form and color perception are affected. In dusk, for example, the semaphore letters may not be distinguished more than 200 or 300 yards at best, and both form and color of flags become illegible. Theoretically, as the light diminishes, the red should appear darker and the blue lighter, so that one might suppose that the color value contrasts would enable us still to distinguish the flags. This is not the case. The blue and red of our signal flags are such that with diminishing light both tend to look black. Another ill effect of reduced illumination is that when it is carried far binoculars no longer aid the vision. In fact, one can see better without them.

On the other hand, the light may be too bright. The sun, shining behind a man semaphoring, a flag hoist, or a searchlight, drowns out the signal, and, in the case of a flag hoist, makes the shape uncertain and the color indistinguishable. It may also so dazzle the receiver that he cannot keep up the effort of reading them. The same is true of the very bright searchlights now used, if the observer is too close to them.

A complete sky background is rarely secured. In semaphore and in wigwag this factor counts immensely. Semaphore hand flags held below the waist line, as in making the letters A, G, H, I, L, X, and Z, are nearly always backed by some object on the bridge, and very often in all positions are obscured by masts or smoke pipes, so that they hardly show at all. The same is true of flag hoists when, as often happens, they are backed by a cage mast, by the shore, or by smoke.

Under the service conditions ordinarily prevailing, the illumination and background, particularly the latter, are more important for the legibility of a signal than is the distance at which the signal is situated. This fact has a special bearing on the visual qualifications that we should demand of the signalman himself.

3. Atmospheric Conditions.—Haze, rain, or snow obviously make signals of all kinds indistinct in proportion to the intensity of the obscuration that they cause; and, moreover, as in the case of diminishing illumination, give trouble because even a moderate obscuration due to these factors renders binoculars useless.

4. Wind.—Unless a ship is under way, a certain amount of wind is needed in order to blow out the flags in a hoist and make them distinguishable. Many of the flags, to be sure, and especially the call-flags and most of the international flags, are so patterned as to be distinguished if even only a small portion shows, and men get quite adept in recognizing them when hanging limp. The call pennants, however, must as a rule be seen in their entirety to be recognized, so that they need some wind to blow them out. A wind blowing straight toward or away from the observer is as bad as no wind at all, and a very gusty wind, which makes the flags flap and foul, is also an obstacle to clear reading. It also interferes greatly with the use of a binocular or telescope, both being hard to hold steady in a strong wind, and the

object swaying as the glass does, only three or four times as much.

Incidentally, a sharp wind blowing right into a signalman's face may suffuse his eyes with moisture and thus blur the signals at a critical moment.

5. Motion of the Ship.—This interferes very considerably both with sending, especially with the semaphore, and with receiving. It is particularly troublesome when binoculars are used, as the latter, of course, magnify every movement.

6. Faulty Technic.—This is one of the most prolific causes of difficulty in making out signals. The careless sender in semaphore chooses a bad background and makes his angles badly, so that his letters cannot be distinguished, and with the searchlight runs his dots together, uses a faulty rhythm, or omits spaces between words. These are a few of the defects known and reprobated on the bridge. They diminish legibility to a very marked degree, and, to that extent, impose additional visual strain on the observer.

7. Use of Binoculars and Telescopes.—A glass is indispensable on the bridge for reading semaphore beyond a third of a mile or flag hoists beyond half a mile. The ordinary glasses double or triple the distance at which signals can be read. On some of the ships powerful telescopes are mounted, with which flag hoists and semaphore can be seen much further. But glasses, and especially telescopes, are hard to use if either sending or receiving ship is rolling, or if there is a high wind, or in wet weather. A mounted telescope naturally is applicable only when the ship is fairly still. In a mist or at dusk, as before remarked, objects cannot be seen any better with a glass than with the naked eye—usually not as well.

Generally speaking, any condition that interferes with the use of a glass is troublesome in proportion to the power of the latter, a fact which limits the use of glasses under service conditions to comparatively low powers.

Conditions Affecting the Signalman Himself. From the above description it is evident that the signalman has to make out instantly and with precision a great variety of objects and a number of variants of the same object, differing either in form or in both form and color, and has also to distinguish light flashes, varying in length and sequence and recurring with great rapidity, and that he must do these things under the most varying conditions of light, shade, background, and weather. Add to this the fact that his work is often carried on under conditions of high tension, hurry, and great responsibility, and we see that the service makes great demands on the visual acuity, the color sense, the light sense and adaptation, muscular coördination, nervous energy, and physical endurance. The relative importance of each of these factors will now be considered.

1. Visual Acuity.—Considering the work that a signalman has to do in the recognition of distant objects, the navy requirements of 20/20 vision for each eye without glasses seem none too severe. If in selected cases glasses are allowed, and I should be in favor of allowing them in such cases, the vision with them ought not to be less than 20/20, each, and it might be well to require 20/15 in at least one eye.

Only in very exceptional cases should a man be allowed to serve on the bridge whose vision without glasses is less than 20/30 in his better eye and less than 20/40 in his poorer eye.

Nevertheless, I am persuaded that visual acuity *per se*, at least as we test it with our charts, is not the most important of the visual factors. For it does not by itself measure the ability to recognize far distant objects when seen under the conditions that prevail on shipboard. More important in this regard is the light sense. To this point we will recur presently.

2. Refraction and the Use of Glasses.—Theoretically, at least, no signalman should have any very high degree of ametropia. Myopes of any considerable degree are, natur-

ally, excluded from the naval service. Hyperopes also may have to be excluded if their error is so high as to make us fear that the accommodation cannot always and readily correct it. In judging this we must remember that on the bridge the accommodation may be weakened by continuous nervous strain or by prolonged deprivation of rest and sleep. Under these conditions even a slight hyperopia may become an excessive burden, and then either the vision blurs or the attention flags. Whether this is likely to happen or not depends largely on the signalman's physique and nervous stability, but unless these are exceptional he should not, I believe, have over one diopter of latent nor over 1.5 D. of total hyperopia. Probably about the same statement can be made with regard to astigmatism.

It is difficult to form a judgment on these matters, because refractive errors are not much in evidence among our signalmen. Of the 101 men who from time to time served on the bridge of the Granite State, only 7 (6 besides myself) wore glasses. The remaining 94, having passed the navy examination, had presumably 20 20 vision in each eye without correction. Of the men wearing glasses, two had two or three diopters of mixed astigmatism, but in the case of one, at least, this seemed to cause no trouble, as he was one of the best receivers on the bridge. The other, myself, had sometimes considerable difficulty in reading signals, but this was apparently due only in a very subordinate degree to the refractive error. Two of the other men had a moderate degree of hyperopic astigmatism. In one the refractive error seemed not to interfere with his work either before or after he put on glasses. In the other, who had anisometropia besides, the refractive error may have had some effect in reducing his efficiency, especially in reading searchlight, but his difficulty may, with more plausibility, be ascribed to his very nervous temperament, which made him give way readily to strain. In the remaining three, one of whom was quite

myopic, the refractive error had no apparent effect on their signaling ability, which was all that could be desired.

So far as such a small number of cases can prove anything, they would indicate that refractive errors in themselves are no essential impediment to signal work. They would also indicate that the wearing of glasses is not incompatible with signaling efficiency. One would, indeed, suppose this to be the case, since signalmen on the bridge constantly use binoculars or telescopes, which are apparently liable to just the same objections as the spectacles that a man wears. Nevertheless, it cannot be denied that under such conditions as prevail on the bridge spectacles are a real inconvenience. They produce disturbing reflections. They readily become dimmed with moisture or marked with grease, and even when clean, apparently cut off enough light to render the recognition of faint distant objects more difficult. Nor is the aid given by glasses in recognizing far distant objects at all comparable with that which they give recognizing test letters at 20 feet. This is a fact that our patients often insist on, and I think we should give it more heed than we are apt to do. In my own case, my vision with glasses is 20 20 and without them is about 20 40. Yet under nearly all conditions of distant vision I can make out faraway flags, semaphore signals, etc., almost if not quite as well without my glasses as with them.

My own judgment on this matter is that, always making exception of the specially qualified man, no one should have a place on the bridge who cannot see far distant objects, but not, necessarily, the ordinary test-card, about as well without glasses as with them. If he can do this and has by the test-card 20 20 with his glasses, and at least 20 40 without, he may be placed on the bridge, and may then either use his glasses or not, as he finds best, although he should be encouraged to do his signaling with them.

3. Color Sense. On the great importance of a keen color

sense there can be no difference of opinion. So many of the flags require for their recognition quick and accurate color discriminations, between shades, often, of about the same light values, that a man who is deficient in this regard would be unserviceable for signaling. Equally important is the ability to distinguish colored lights, particularly the green starboard and red port light of a vessel under way, and the variously disposed red lights which distinguish pilot vessels, fishing vessels, cable ships, and various other vessels of special character.

4. Light Sense and Adaptation.—Acute light sense and ready adaptation are essential qualifications of a signalman. It is indispensable that he should be able to distinguish readily a dark object against another nearly as dark, should make out colors, movements, and shapes against a background which affords but little contrast, and should see well in rapidly fading twilight and in murky weather. It is also important that he should be able to stand the glare of the sun shining on the water or behind the signal, or the powerful searchlight, without getting dazzled or fatigued.

Bridge work, and especially the reading of searchlight signals, in which bright flashes of light alternate with darkness, require quick adaptation and a mobile pupil.

Compared with a good light sense, visual acuity is of subordinate importance, and for that reason our visual tests, as ordinarily conducted, do not give the best idea of the availability of a candidate for bridge work. If we have no photometer with which the light sense can be measured accurately, the latter may be determined by tests made under actual service conditions, *i. e.*, by making the candidate pick up distant objects and describe their form and color, when viewing them under varying and especially under unfavorable conditions of illumination and background.

5. Motor Anomalies of the Eye.—I should say that these

affect a signalman's efficiency to only a very subordinate degree. As vision is concerned altogether with distant objects, errors of convergence and accommodation cause no particular trouble. A man who has a tendency to diplopia in distant vision, *e. g.*, from weak externi or from hyperphoria, may be confused, especially in taking searchlight signals; and, of course, eyes so affected tend to give out sooner than do those that can easily maintain binocular fixation and binocular vision.

6. Reaction Time.—Nowhere, except in the turret or at the wheel, is the slowly reacting man more out of place than on the bridge. On the bridge a man must be constantly on the alert for visual impressions of all kinds and coming from all quarters, must take them in instantaneously, realize their significance, and act on them without a second's delay. This means that he must be quick to react properly to any stimulus, whether signal, order, or question.

7. Mental and Nervous Stability.—The ideal bridge man is one who is neither stolid nor erratic, but one in whom quickness of body and mind and a superabundant energy are combined with steadiness under all conditions, an even temper, and a happy disposition. He is one that is quick and eager to learn, enthusiastic, in love with signaling, industrious, always amenable to discipline, yet always also capable of independent thought and action, and, above all, he is reliable.

A man who has these characteristics I would pick out for the bridge, even if he had some apparently prohibitive visual defects and refractive errors. He would, as I know, make good in spite of them. And a man of opposite characteristics I would not have, no matter what his vision. It requires a special disposition and aptitude of mind to be a signalman, and it is not worth while to try to train those who are either indifferent or unmanageable. The work is too important to be put into such hands.

8. Physical Strength and Endurance.—To do his work under the trying conditions that often prevail on shipboard, the signalman must have plenty of strength and endurance, otherwise he may break down physically or may be unable to maintain the visual effort required. Owing to the rigid entrance requirements of the navy and the wholesome character of life on board ship, the men usually have the superabundance of strength and vitality that enables them to perform signal duty.

CONCLUSIONS.

My observations have led me to the following conclusions:

1. The visibility and legibility of our signal and other flags could be much improved if the blues were made much lighter, the reds were made somewhat lighter, and care was always taken not to make the yellows too light.

It would also be better if the pennants had a rounded or obtuse, instead of a finely tapering tip, as this part of the flag becomes hard to read in proportion as it tapers down.

2. The ocular requirements that we should lay down for a candidate for signal work should always be considered in connection with his other physical and his mental qualifications and to a certain extent should vary with these.

A like correlation between the strictly physical qualifications and the general mental and moral make-up of the candidate should, I believe, be made in the case of all candidates for military and civil positions. This is done now to some extent, but the principle might be extended with advantage. As I have elsewhere remarked, this correlation is best effected if the medical officer who makes the physical tests and the professional expert, who gauges the probable availability of the candidate from a technical standpoint, work hand in hand.

3. In making such a correlation we must distinguish between the visual requirements which, being indispensable,

for the purpose in hand, are necessarily inflexible, and those in which more latitude may be allowed.

4. For signaling the ideal visual requirements are: Visual acuity of 20/20 in each eye without correction; perfect color sense; first-rate light sense and quick adaptation; orthophoria for distance and near, with good converging and especially with good diverging power; quick reaction time.

5. Of these requirements, three are indispensable, viz., perfect color sense, first-rate light sense, and quick reaction time. Coupled with these there must be a good all-round physical condition.

6. To test these matters in a practical way I would first take each applicant's vision; examine his color sense with the lantern and with other tests, of which, I think, the most available are Nagel's and Stilling's; if a photometer could be had, I should measure his light sense with it, and, if I had no photometer, would test out the light sense by making the applicant pick up faint distant objects under difficult visual conditions; I would apply some simple psychologic tests to ascertain his reaction time and quickness in making mental discriminations; and would determine his muscle balance for distance and near and his converging and diverging power.

Those who showed deficiency in color sense or light sense were markedly slow in their reactions, or were evidently below par in their physical and mental vigor, I would reject at once. The rest I would place in a signal class, conducted at first below decks, later on the bridge.

7. Of the men so placed, I would put those with subnormal vision or abnormal motility in a probationary class. While they were in this I would ascertain the cause of their deficient sight, and if it was due to a refractive error would correct it.

8. Those of the signal class who displayed marked enthusiasm and readiness in learning, and steadiness and re-

liability in their work, coupled with the ability to discern far-distant signals or objects under all sorts of service conditions, especially when the contrasts were poor, I would admit to permanent service on the bridge even if their visual acuity was not up to the full standard. I should, indeed, think it proper, in the case of specially good men, to take them on even if their uncorrected vision was 20 40 or less, so that they could not see distant objects by any means as well without their glasses as with them. Such men, of course, would have to do their work on the bridge with glasses, which, after all, are only a relative handicap.

On the other hand, no matter how perfect a man's vision was and no matter how technically well fitted he seemed, I would not have him on the bridge if the preliminary work in the signal class showed that he was erratic, quarrelsome, did his duties carelessly, perfunctorily, or reluctantly, or if he was unreliable.

In fine, my idea is that the initial physical examination should be more or less elastic and tentative, eliminating simply those who are absolutely unfit, but admitting to further trial under service conditions all the other applicants, whether visually below standard or not; and that when this further trial has disclosed what each man's visual, mental, and moral qualifications are, the signal officer with, if necessary, the aid of the surgeon, should determine which of the men under investigation are fit for duty on the bridge.

DISCUSSION.

DR. ALEXANDER DUANE, New York: I have succeeded in detecting two cases of malingering by another application of the prisms: one that would produce, if the patient were really using two eyes, a confusing diplopia; but that, if he were really excluding one eye, would not cause confusion. I have succeeded in that way in convincing the friends of the person, in accident cases, that he was either self-misled or misleading them.

A BRIEF HISTORY OF THE FORMATION OF THE DIVISION OF HEAD SURGERY, WITH SPECIAL REFERENCE TO OPHTHALMOLOGY.

WALTER R. PARKER, M.D.,
Detroit, Michigan.

History.—At the suggestion of Dr. James Bordley, Jr., and on recommendation of the Executive Committee of the General Medical Board of the Council of National Defense, a Subcommittee of Ophthalmology, to form an integral portion of its Division of Surgical Specialties, was appointed on May 4, 1917, as follows: Dr. James Bordley, Jr., Chairman; Dr. G. E. de Schweinitz, Dr. Allen Greenwood, Dr. Nelson M. Black, Dr. Walter R. Parker, Dr. W. H. Wilmer.

On June 22, 1917, Dr. Charles W. Richardson, Chairman of a Committee which had been appointed on March 13, 1917, by the Presidents of the American Otological Society, the American Laryngological Society, the American Laryngological, Rhinological and Otological Society, and the Laryngological and Otological Section of the American Medical Association, presented a plea to the Chairman of the Executive Committee of the General Medical Board of the Council of National Defense that this Committee should be created a subcommittee on Otolaryngology of the Surgical Specialties of the General Medical Board of the Council of National Defense. In this plea was set forth the work which this Committee had already accomplished and reported to the Medical Section of the Council of National Defense, and to the Surgeon General of the United States army, with reference to the best methods of utilizing the activities of men and materials represented by its Association in the work of medical preparedness.

As early as May 14, 1917, Dr. James Bordley, Jr., and Dr. Nelson M. Black had suggested, in consultation with Dr. Franklin Martin, Advisory Member of the Council of National Defense, the establishment of such a Subcommittee of Otolaryngology, and therefore it naturally followed that the Committee described should be authorized to continue its work. This authorization was received on June 22, 1917, but the Committee was not officially appointed by the Council of National Defense until August 15, 1917.

Prior to its affiliation with the Council of National Defense it had enlarged its personnel by the addition of an officer from the Medical Corps of the United States army and an officer from the Medical Corps of the United States navy. Thus the Subcommittee on Otolaryngology of the Surgical Specialties of the General Medical Board of the Council of National Defense was created, dating its authorization "to proceed with the work" from June 28, 1917, and its formal approval by the Council from August 15, 1917, with the following personnel: Dr. Charles W. Richardson, Chairman; Dr. Harris P. Mosher, Dr. Burt R. Shurly, Major T. C. Lyster, Medical Corps, U. S. A., Surgeon C. E. Trible, Medical Corps, U. S. N.

Later, when Dr. Shurly went abroad as director of Base Hospital No. 26, Dr. Joseph H. Bryan was made a member of this Committee.

The work of the Subcommittee of Ophthalmology began with the preparation of a list of the ophthalmologists of the country, which included nearly 9000. To each one a questionnaire was sent on June 13, 1917, and the replies were classified according to the answer. After eliminating those who were disqualified by age, physical disability, serious family responsibilities, duties in medical schools, and the necessity of serving the civilian population, also those who declined to serve and those who could not serve because they were already on government duty, the

Committee was able, by October 30, 1917, to record the names of over 1400 men who had signified their willingness to serve and who were qualified to do so. As fast as the acceptances were received they were indexed on suitable cards and placed in the files of the record room of the Surgeon General's office.

The work of the Subcommittee of Otolaryngology began with the preparation of a list of the otolaryngologists of the country, and 5600 names were included in it. To each one a questionnaire similar to the one which had been used by the Subcommittee of Ophthalmology was sent, and the replies were classified in the manner already noted. The questionnaires were mailed on July 9, 1917, and by August 15, 1917, over 2000 replies had been received, with 196 acceptances of service.

Early in July, 1917, as the result of a consultation between Major T. C. Lyster, Dr. James Bordley, Jr., and Dr. Charles W. Richardson, it was decided to obtain approval for joint conferences of the two committees, and thus to provide unity of effort. To bring this about the first informal meeting took place on July 7, 1917. It was further decided to obtain approval for the addition to the Subcommittee on Otolaryngology of an oral and plastic surgeon, and for the addition to the Subcommittee on Ophthalmology of a brain surgeon.

Formal approval of the acts of this conference and of its suggestions was received from the Chairman of the Executive Committee of the Council of National Defense on July 10, 1917. Thus was formed, with the following personnel, the Committee on Surgery of the Head.

Ophthalmology and Brain Surgery: W. H. Wilmer, Chairman; Nelson M. Black, Secretary; James Bordley, Jr., G. E. de Schweinitz, Allen Greenwood, Walter R. Parker, Charles Bagley, Jr.

Otolaryngology and Oral and Plastic Surgery: Charles W.

Richardson, Harris P. Mosher, Burt R. Shurly, V. P. Blair, Major Theodore C. Lyster, M.C., U. S. A.: Surgeon G. E. Trible, U. S. N.

The new members of the Joint Committee (Committee on Surgery of the Head), namely, Dr. Charles Bagley, Jr., the representative of brain surgery, and Captain V. P. Blair, the representative of oral and plastic surgery, proceeded, by means of questionnaires signed by their respective committees, to classify the surgeons of the country who were fitted to assume the obligations of brain surgery and oral and plastic surgery, or who were willing to fit themselves by special instruction to assume such duties, in all respects following the plan which had been pursued by the Committees of Ophthalmology and Otolaryngology. On suitable cards the names of those willing to accept service in these departments were filed in the record room of the Surgeon General's office.

The Surgeon General of the army determined upon the establishment of a Division of Surgery of the Head (Head Surgery) in his office, to be under the charge of Major T. C. Lyster, its personnel to be recruited from the Committees on Surgery of the Head (Head Surgical Committee) and those selected to be commissioned in the Medical Reserve Corps of the army. This plan was consummated on July 9, 1917, and quarters in the Surgeon General's office were assigned and opened. The following members were selected to serve on Major T. C. Lyster's Staff: Dr. Nelson M. Black, Dr. Harris P. Mosher, Dr. Charles Bagley, Jr., Captain V. P. Blair.

Thus was formed, with the following commissioned personnel, the Division of Surgery of the Head (Head Surgery) of the Surgeon General's office: Major T. C. Lyster, M.C., U. S. Army, Chief of Division. Major Nelson M. Black, M.R.C., date of commission and assignment, July 23, 1917, in charge of ophthalmology. Major Harris P. Mosher,

M.R.C., date of commission and assignment, August 7, 1917, in charge of otolaryngology. Captain Charles Bagley, Jr., M.R.C., assigned July 11, 1917, commissioned August 7, 1917, in charge of brain surgery. Captain V. P. Blair, M.R.C., transferred from Fort Oglethorpe July 24, 1917, in charge of oral and plastic surgery.

On August 15, 1917, these Committees were informed by Lieutenant Colonel T. C. Lyster, Chief of the Division of Surgery of the Head of the Surgeon General's office, that the Surgeon General authorized the preparation of plans for a special hospital to be devoted to surgery of the head (Head Hospital), of 1000-bed capacity, to be operated in France in connection with the hospitals of the A. E. F. Therefore, on August 17, 1917, these committees formed a series of subcommittees to carry out this authorization of the Surgeon General, as follows:

SUBCOMMITTEES ON HEAD HOSPITAL.—*Personnel Committee.*—Dr. Allen Greenwood, Chairman; Dr. C. W. Richardson, Captain Charles Bagley, Jr., Major V. P. Blair, Major H. P. Mosher.

Shop Committee.—Dr. W. H. Wilmer, Chairman; Major V. P. Blair, Major Nelson M. Black, Dr. C. W. Richardson.

Equipment Committee.—Dr. G. E. de Schweinitz, Chairman; Major H. P. Mosher, Major V. P. Blair, Captain Charles Bagley, Jr.

Hospital Construction Committee.—Dr. Walter R. Parker, Chairman; Major H. P. Mosher, Major Nelson M. Black, Dr. James Bordley, Jr.

For many weeks the members of these subcommittees worked on plans, personnel, plans of construction, shop fittings, instruments, and general equipment, and were in constant consultation in these regards with the supply departments of the army, with the American Red Cross, with architects, laboratories, optical firms, manufacturers, directors of base hospitals already established in the Army Medical Ser-

vice, and ultimately elaborated and completed their generous plans, which, with the cost involved, were handed to the Surgeon General of the army and received his approval.

With the ever-increasing activities of the Committee of Surgery of the Head, and of the Division of Surgery of the Head of the Surgeon General's office, it became necessary to increase the personnel of the latter organization as follows:

Major H. G. Sellig, M.R.C., assistant in neuro-surgery. Captain Robert H. Ivy, M.R.C., assistant in oral and plastic surgery. Lieut. H. N. Kerr, M.R.C., assistant in brain surgery. Major Walter R. Parker, M.R.C., assigned to Section of Ophthalmology with special reference to construction of special hospitals. Major Allen Greenwood, M.R.C., assigned to Section of Ophthalmology, with special duty in reference to personnel of the special hospitals for Surgery of the Head. Major G. E. de Schweinitz, M.R.C., Section of Ophthalmology, Division of Surgery of the Head, Surgeon General's office, with duty in reference to compiling material for Manual of Ophthalmology. Capt. Grover C. Penberthy, M.R.C., assigned as assistant, Section of Brain Surgery.

On September 29, 1917, all of the members of the subcommittees of ophthalmology and otolaryngology of the Council of National Defense having been called into active medical military service, these committees ceased to exist, all of their work being merged into the Division of Surgery of the Head, of the Surgeon General's office, Major W. H. Wilmer and Major Burt R. Shurly being the only members of the joint Committee who were not detailed to the Surgeon General's office.

Major James Bordley, Jr., promoted Lieutenant Colonel, M.C.N.A., May 21, 1918, commissioned September 22, 1917, and detailed to the Surgeon General's office, was soon ordered to special duties in the Department of Reconstruction.

Ultimately, that is after September 29, 1917, all functions were concentrated into the Division of Surgery of the Head of the Surgeon General's office, consisting of the Sections of Ophthalmology, Otolaryngology, Brain Surgery, and Oral and Plastic Surgery. This organization continued in the work of the selection and classification of surgeons from civil life, having special training in the examination and treatment of diseases and injuries of the head, and developed arrangements whereby intensive training could be given to other surgeons not as yet fully qualified in these regards, the whole purpose being to make available medical reserve officers well qualified for duty in base, general, and reconstruction hospitals in this country and overseas.

Organization of the Division in the Surgeon General's Office.—As originally organized, Surgery of the Head was administered in the Surgeon General's office as a division. This organization continued until November 30, 1918, when, in accordance with Office Order No. 97, it was changed to Section of Head Surgery in the Division of Surgery, the section including Ophthalmology, Otolaryngology, Neurosurgery, and Oral and Plastic Surgery.

Administration.—The Division of Surgery of the Head was administered by a chief of the division and an officer in charge of each of the four sections, together with assistants.

The names of the officers who served in this division, together with their other assignments, follow:

Colonel T. C. Lyster was in charge of the division from the time of its organization until October 23, 1917, when he was ordered abroad on a tour of inspection. On his return, while he acted in an advisory capacity in the affairs of the Division of Surgery of the Head, he did not resume active charge, his duties as "Officer in Charge of the Air Service Medical," and later as Director of the Professional Services in the Surgeon General's office, occupying most of his attention.

Major (now Colonel) Walter R. Parker was designated "Officer in Charge of the Division during the temporary absence of Colonel Lyster." After Colonel Lyster's return from abroad on March 1, 1918, Colonel Parker continued to act as Chief of the Division, and on June 8, 1918, was appointed "Officer in Charge," in which position he continued until the time of his discharge from the service, April 2, 1919. In addition to his duties as Chief of the Division, Colonel Parker was a member of the board (S. O. 303, December 21, 1917) appointed for the purpose of revising the regulation for the physical examination of applicants for enlistment in the army and registrants within the selective draft regulations. He was also a consultant at the Walter Reed General Hospital (S. O. 153, July 1, 1918); a member of the General Publicity Board (Office order No. 78, August 3, 1918), and one of the authors of Medical War Manual No. 3, "Military Ophthalmic Surgery." Colonel Parker was honorably discharged from the service April 2, 1918.

Ophthalmology.—Major (now Lieutenant Colonel) Nelson M. Black was in charge of the Section of Ophthalmology from the time of its organization, July 9, 1917, until June 12, 1918, when he was ordered for "extended field service overseas." In connection with his duties as Officer in Charge of Ophthalmology, Colonel Black made extensive inspection tours, visiting nearly all the cantonment base hospitals. He has made an extensive study of the trachoma question in relation to the army and the methods of treatment used by the Public Health Service. While on duty in the A. E. F. he was appointed assistant consultant in ophthalmology September 3, 1918, and senior consultant in ophthalmology and otolaryngology, A. E. F., January 9, 1919. On March 8, 1919, he was ordered to the Surgeon General's office for duty, and when Colonel Parker was discharged from the service, April 2, 1919, Lieutenant Colonel Black was made Chief of the Section of Head Surgery under the new organi-

zation. In this capacity he had charge of ophthalmology and otolaryngology in addition to his administrative work.

Major (now Lieutenant Colonel) George E. de Schweinitz was ordered to duty in the Surgeon General's office September 29, 1917, for the purpose of compiling a Manual of Ophthalmology for the Surgeon General. On the completion of this work he was ordered on a tour of inspection abroad, together with Colonel Lyster and Colonel Mosher, as members of the Division of Head Surgery (S. O. No. 92, Par. 10). He was absent on this duty from October 11, 1917, until March 1, 1918. He reported for duty in the Surgeon General's office March 2, 1918, and worked in the Section of Ophthalmology until April 2, 1918, when he was put temporarily in charge. On July 11, 1918, he was appointed Officer in Charge of Ophthalmology, which position he held until his discharge from the army April 2, 1919. In compliance with Order A. G. O. 27168, July 23, 1918, Colonel de Schweinitz, in connection with his duties as Officer in Charge of Ophthalmology, organized the School of Ophthalmology at Fort Oglethorpe, Georgia. He was also appointed to edit the clinical and pathological material of ophthalmology for the medical history of the war, and made a member of the editorial board for passing on material for the successive volumes of medical history of the war. On December 24, 1918, he was appointed Consultant in Ophthalmology, and honorably discharged from the service April 2, 1919.

Major (now Lieutenant Colonel) Allen Greenwood was ordered to duty in the Surgeon General's office on September 22, 1917, in charge of the personnel of the special head hospital, and later organized the optical units for service in the A. E. F. He was editor of Medical War Manual No. 3, "Military Ophthalmic Surgery." He accompanied the optical units overseas as commanding officer, and shortly after reporting to headquarters in France was made Senior Consultant in Ophthalmology in the A. E. F. He returned

from abroad on January 29, 1919, and was honorably discharged from the service February 11, 1919.

Major William E. Bruner was ordered to active duty as Assistant in Ophthalmology on August 19, 1918. He continued in this work until the date of his honorable discharge, November 26, 1918.

Each section was responsible not only for its personnel but for the equipment and materials required, also for all the details of routine administration, including instruction and special publications. At the beginning of the war there was a sufficient number of ophthalmologists and otolaryngologists to meet the requirements. But such was not the case in oral-plastic and brain surgery. In fact, there were very few who could qualify as experts in these branches. To meet this emergency it became necessary to establish schools to which officers with training in the fundamentals of general surgery could be sent for intensive instruction. While this training could not make specialists in any sense of the word, it did equip those who took the courses to do better work in an emergency than they could otherwise have done. In addition to the instruction in the schools, an effort was made to give systematic courses in all branches of surgery in the cantonment base hospitals.

The instruction given in the special schools was most successful, but with few exceptions that given in the cantonment base hospitals was a failure. The reason for this lack of success was due partly to insufficient time at the disposal of the officers, and in a measure to want of sympathy with the plan on the part of those in charge. Most of the officers were sent to the hospitals direct from civil life, and their time was consumed in drilling, familiarizing themselves with the routine, and doing the necessary paper work. While the clinical material in the cantonment base hospitals in this country was almost nil in oral-plastic and brain surgery, it was abundant in ophthalmology and otolaryngology. On

the other hand, the number of returned injured soldiers requiring oral-plastic and neurosurgical care was larger than that requiring the attention of the ophthalmologist or the otolaryngologist. It is necessary, therefore, in considering the value of the work accomplished through the formation of a Division of Head Surgery, to consider the whole field, and not to judge either from the work required in the cantonment base hospitals or in the general hospitals designed for the care of the returned soldiers.

The number of medical officers in the army at the beginning of the war was 422, while at the time of the signing of the Armistice there were over 31,000 enrolled. Thus the situation was suddenly changed, at least from a clinical standpoint, from army to civilian conditions. In civil practice very few if any surgeons are equipped to be equally proficient in all branches of their profession, and the adjustment of the civilian surgeon to the military requirements became a great problem. As the emergency would not permit of material changes in the qualifications of the volunteer officers, the obvious thing to do was to take the material at hand and utilize it to the best advantage. At the beginning of the war there were three training camps for medical officers, namely, Fort Benjamin Harrison, Fort Riley, and Fort Oglethorpe. The instruction in these camps was military, including paper work required by the medical officers. Fort Benjamin Harrison was soon abandoned, and later Fort Riley was designated for the training of medical officers and corps men for sanitary trains and regimental detachments, while Oglethorpe was retained as the only training camp for medical officers and men for all branches of the medical service. Finally, schools were established at Oglethorpe for instruction in all branches of medicine and surgery, including the surgical specialties. Officers were allowed to choose the course they wished to take, but before being admitted were given an examination to determine their

fitness. An examination was conducted at the end of each course of instruction, and only those who were able to pass satisfactorily were recommended to be retained in the Surgeon General's office as qualified for assignment in special surgery. The plan worked admirably, and in case of another such emergency it would be wise to institute from the first a similar scheme of classification and instruction.

Lieutenant Colonel de Schweinitz organized the course in ophthalmology at Oglethorpe and Major Meyer Wiener was put in charge. The excellent results accomplished through their efforts was a determining factor in establishing this specialty as a necessary part of the organization of the Medical Department of the army.

A special hospital was established at Cape May for the reception and treatment of all cases requiring the care of specialists represented by the component sections of the Division of Head Surgery. This hospital, known as General Hospital No. 11, had a precarious beginning, due to uncertainty of tenure. Because of this complication the authorities naturally hesitated to develop and equip this hospital. Not until the wounded soldiers began to return was the necessity of such a center fully appreciated. At once the status of the hospital was fixed, and it still functionates to its full capacity of 750 beds. Lieutenant Colonel Frazier is chief of the Surgical Service, and no one of the hospitals designated for the care of the returned injured soldiers is doing better work. Major Chance, Major Wiener, and Captain Cross were at various times in charge of ophthalmology in this hospital. In addition to the cases of head and neural surgery, all the deaf were sent to Cape May for reëducation. This department was organized by Lieutenant-Colonel Richardson, and has been a success. The education of the deaf, as well as the care and rehabilitation of the blind at General Hospital No. 7 at Baltimore, organized by Lieutenant Colonel Bordley, are under the Division of Recon-

struction, and were not among the activities of the Division of Head Surgery. There was also organized a special hospital for service in the A. E. F. Lieutenant Colonel Ellett was commanding officer, and Captain L. Masten Francis was in charge of ophthalmology.

The Section of Ophthalmology not only suggested means of supplying the soldiers with glasses, but organized and equipped an optical plant and fourteen mobile units for service abroad. This organization was developed by Lieutenant Colonel Greenwood, who took the central plant and eight units abroad, the remaining six being sent later. Colonel Greenwood was subsequently made Senior Consultant of Ophthalmology of the A. E. F., and was assisted by Lieutenant Colonel Derby and Lieutenant Colonel Black. Full account of what they accomplished has been given elsewhere.

When the division was first organized, officers were given a departmental order, assigning them to special duty in a hospital, ophthalmology, for instance. For military reasons this was changed and officers were simply assigned for duty in the hospital, the commanding officer being given authority to assign officers in an emergency to any duty he saw fit. At the same time a letter was sent to the commanding officer acquainting him with the special qualifications of each officer so ordered. The commanding officer being responsible for the management and conduct of his hospital, naturally would, in so far as possible, assign each surgeon duties which he was best qualified to perform. Great sympathy is due officers who, in the judgment of the commanding officer, had demonstrated marked ability not only in his specialty, but as an administrative officer. There was very little complaint, however, and many who entered the service to do special work and were assigned to a desk won great credit by adapting themselves to war conditions and doing their best in the emergency. But under the plan of organization the ad-

ministrative work had to be done by members of the medical staff, a condition for which the officer in command was not responsible.

The total number of officers assigned to duty by the Division of Head Surgery was 1530, distributed as follows: Ophthalmology, 612; otolaryngology, 491; oral and plastic, 230; brain surgery, 197.

The number given as assigned to oral-plastic and brain surgery included those sent to schools for special training.

Returned Soldiers.—Originally it was planned to distribute the returned injured soldiers geographically, but when the patients requiring immediate special treatment began to return in large numbers, it became apparent that centers would have to be established where experts of known reputation could be assigned and made responsible for the work. The eye cases were sent to six general hospitals, where, in each instance, a special staff was provided. Finally the cases were sent directly from the post of debarkation to the designated hospitals. Although there was much opposition to this plan of concentration, both political and sentimental, the judgment of the Surgeon General in putting the proper care of the soldiers first was fully justified by the clinical results obtained.

The development of the Division of Head Surgery was a war measure. In a peace organization of the Medical Department of the army there is little need for oral-plastic and neuro surgeons, and special sections in these branches have been discontinued as a part of the organization of the Surgeon General's office. Ophthalmology and otolaryngology, however, have been retained in the new organization and, combined, are likely to remain as a Section in the Division of Surgery.

The fact that the specialties were recognized for the first time by the Medical Department of the army is an interesting commentary on the change in medical practice. The

broad experience gained in the war may contribute to an adjustment of the proper relation of the various branches of medicine and surgery, both in civil and military practice.

DISCUSSION.

DR. ALLEN GREENWOOD, Boston: A great deal of commendation has been handed out, during the last few days, to the men who went overseas, but I think that in many ways they had the best of it, so far as a really interesting and strenuous life is concerned. All the work that was done abroad was, however, predicated by the work that was done in the Surgeon General's Office; and no man in America has done so much for the specialties in the army as Colonel Parker. I was very closely associated with him in the early days of the Section on Surgery of the Head, and I know of the many anxious nights that he spent wondering whether the section was to live or pass away. It is due to his efforts, working with the general surgeons and convincing them of the necessity for the specialists, that we have gained what we have today for ophthalmology and the other specialties.

DR. GEORGE E. DE SCHWEINITZ, Philadelphia: The former Chief of the Division of Surgery of the Head, Colonel Parker, permits me to make an addendum to his paper. While it is perfectly true that instruction in the head specialties in Base Hospitals, particularly in ophthalmology, was not universally a brilliant success, there were notable exceptions. For example, an excellent school, under the control of the late Lieutenant Colonel Todd, at Camp Custer, was most satisfactory. Another successful course of instruction existed at Camp Lewis, under the direction of Captain Würdemann. Not only ophthalmologists were taught, but also all those who were interested in the problems of ophthalmology in their relation to general medicine.

OCULAR MANIFESTATIONS FOLLOWING EXPOSURE TO VARIOUS TYPES OF POISONOUS GASES.

GEORGE S. DERBY, M.D.,
Boston.

In 1915 the Germans began to use gas for the purpose of disabling their opponents. This was first used in the form of drift or cloud gas. Among the varieties sent over was the so-called lacrimatory gas, which was used for the purpose of temporary disablement. Lacrimatory gas caused intense burning pain, profuse lacrimation, and injection of the conjunctiva. The men who had been gassed showed marked photophobia and watering, the palpebral borders were swollen and showed erythematous lesions, which followed rubbing with the hand and the handkerchief. There was marked conjunctival injection and occasional chemosis. According to Gremeaux,[1] the cornea presented in its peripheral portion a fine exfoliation of the epithelial covering. The milder cases recovered very quickly. The corneal lesions showed no tendency to extend. The more severe cases were usually well within two weeks, or then only showed a slight photophobia and watering, which disappeared at the end of three weeks or a month. The reaction was always more severe when a bandage had been used on the eye.

Much more serious were the injuries produced by mustard gas (dichlorethylsulphid). This gas was first made by Victor Meyer in 1886. He described it as a heavy, oily fluid, sinking in water, and not miscible with it, of neutral reaction, having a faint sweetish ethereal odor slightly suggestive of the sulphur compounds, with a boiling point of 217° C. One of his

The inserts in Dr. Derby's article have been reproduced through the courtesy of the Medical Research Committee of the British War Office.

Severely burned eye in the acute stage.

Slightly later stage of acute burning.

laboratory workers engaged in making it developed skin eruptions with a transitory conjunctivitis. Meyer himself was not affected by it, and therefore concluded that individual susceptibilities vary greatly. He also concluded that injection of this compound could produce metastatic lesions.

Mustard gas was sent over in shells, the so-called yellow cross-shells. It was first used extensively at Ypres on July 12-13, 1917. Mustard gas causes sneezing, followed by increasing nose and throat irritation. There is painful irritation of the eyes and sometimes vomiting. The action is a delayed one, and takes place in from two to six hours, with increasing inflammation of the mucous membrane and the skin. Severe erythema of the skin develops, followed by blistering. The moist portions of the body are more severely affected. Respiratory symptoms develop, and in severe cases bronchitis and secondary pneumonia may be seen in thirty-six to forty-eight hours. Pneumonia is the most frequent cause of death.

All grades of mustard gas involvement of the eyes may be met with. They may be divided into slight, moderate, and severe. The slight cases form 75 per cent. or 80 per cent. of those affected. Often, in the mild cases the subjective symptoms are severe. The lids are held tightly closed. There is profuse lacrimation and a considerable degree of injection of the conjunctiva.

In those more severely affected, the lids always show a considerable amount of redness and swelling and often the formation of numerous bullæ. The lid margins are sometimes excoriated. The lids are held closely pressed together, and any attempt to separate them is accompanied by severe pain, so that often it is necessary to use one or two drops of cocain and employ a lid elevator in order to get a good view of the conjunctiva and cornea. The conjunctiva is markedly injected throughout, and may show a considerable degree of chemosis, which is most marked in the upper and lower conjunctival folds, which may project beyond the lids. Often the injec-

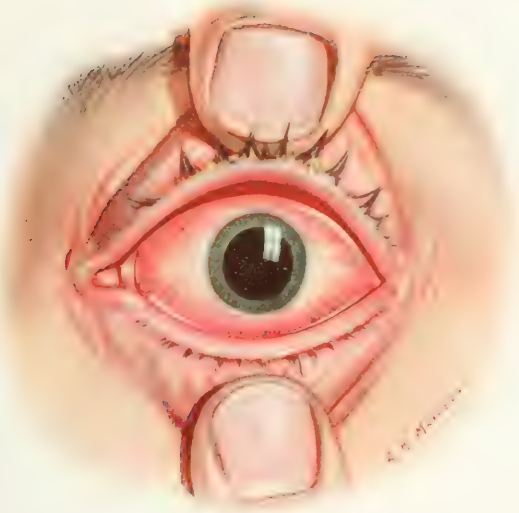
tion is of the distinct ciliary type. The region of the palpebral fissure is the most severely affected. In severely burned cases there is often an area of solid white edema of the conjunctiva in the palpebral fissure, which presents a very striking appearance.

The corneal lesions are also of varying severity. In the milder cases there is only a very slight roughening of the corneal epithelium, which may or may not stain with fluorescein. In the moderately severe cases, there is a marked roughening of the epithelium with irregular grayish areas of opacity scattered throughout the cornea. Our British colleagues liken the appearance of the cornea in these cases to that of an orange skin. The area of the palpebral fissure always shows the most marked changes.

In the most severe cases a very saturated gray band is seen traversing the cornea in the area of the palpebral fissure, and this band is sometimes of almost porcelain whiteness. The roughening of the cornea is due to edema of the epithelium and later on to exfoliation. Where corneal involvement is marked, fluorescein staining takes place.

Secondary conjunctivitis, especially when the eyes have been bandaged, is prone to develop; and secondary infection of the cornea may take place and may result in ulceration, and later even panophthalmitis and a loss of the eye. Luckily, such cases are comparatively rare.

The British Consultants have observed only about ten cases of corneal ulceration where impairment of vision was left behind. In four cases, panophthalmitis developed and the eye was eventually removed. Among 1500 cases, Teulières[2] saw one case of panophthalmitis and three cases of ulceration of the cornea. During the eighteen months preceding the armistice, about ten cases of corneal ulceration came under my observation—two of these were seen while serving with the British, but none of these were under my actual care, although many hundreds of gassed men passed through the



Stage of resolution after severe burning.

Late stage of resolution.

hands of the hospital unit I was serving with at that time. A number of damaged eyes were seen while serving with the American Expeditionary Forces. One unfortunate was well on the road to losing both eyes, largely, I believe, due to bandaging and to the lack of proper care. One case was seen where apparently no secondary infection of any severity had taken place, and yet marked opacity of the cornea was present after many weeks which promised to be permanent. I call to mind another case where, after the process had almost entirely resolved and the cornea was bright and clear, a secondary ulceration developed of a severe nature, apparently due to a lowered vitality of the tissue. Ring abscess of the cornea has been noted by several British observers.

The lesions of mustard gas are in the nature of a chemical burn of the tissues of the eye. Warthin likens it more especially to the effect produced by hydrochloric acid. Pissarelio[3] has exceptionally seen cicatricial ectropion following burns from mustard gas. Lister says that occasionally the actual liquid from the yellow cross-shell passes into the eye. The lesion then is similar to that produced by burns from other liquid caustics, and necrosis, ulceration of opposed surfaces, and symblepharon may occur. Personally, I have not seen such cases.

Teulières and Valois[4] describe slight iritis, cloudiness of the papilla, slaty tint of the retina, and congestion of the retinal veins. They describe this as a benign neuroretinitis. One may see a questionable hyperemia of the disc and retina, but it is altogether unlikely that disease of the posterior half of the eyeball following exposure to mustard gas occurs.

Cèrise, in his report to the French Ophthalmological Society in March, 1918, divides the cases into three groups:

1. Benign, representing 10 to 15 per cent. of cases. Duration, ten to fifteen days.

2. Medium, about 80 per cent. of cases. Duration, five to six weeks.

3. Severe, 3 to 5 per cent. of cases; with marked general symptoms, often developing a bronchopneumonia.

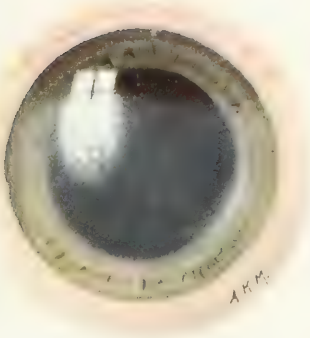
In our experience and in that of our British colleagues, the mild cases form a much larger percentage. In the first place, there are a very large number of mild cases of gassing which are never sent back to the hospital.

In the mild cases which reach the hospitals, recovery is rapid, and they may usually be sent back to duty in from one to two weeks. The moderately severe cases may have a duration of four weeks to two months and even longer. The conjunctival chemosis subsides fairly quickly. The white areas of edema often take one to two weeks to disappear, and are replaced by an intensely red area. Colonel Lister calls attention to a peculiar mauve tint in these cases similar to that seen in certain cases of episcleritis. It may be two to four months before the most severe cases may be returned to duty.

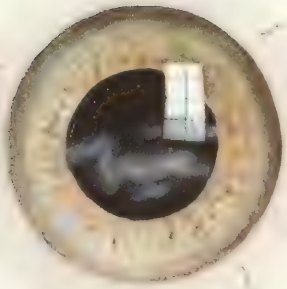
Patients subject to chronic conjunctivitis and blepharitis often have their old condition lighted up by gas, and are then very resistant to treatment. Certain individuals develop a neurotic condition following exposure to gas. It is characterized by lacrimation and photophobia. This is probably due, at least in part, to the strong nervous impression produced upon the man by the severe irritation of the eye which the gas causes. He fears that he is about to become blind. Moreover, his general condition has often been impaired. Unless he is properly handled at this time, his convalescence is apt to be much prolonged, and certain of these men develop into malingerers.

TREATMENT.

The gas mask when worn protects the wearer against the effects of mustard gas in the eyes and also in the respiratory passages. Naturally, it does not protect against skin lesions. When the soldier receives his first bathing after exposure to



Drawing of the cornea in the acute stage of severe burning.



Drawing of cornea in the stage of resolution after severe burning.

mustard gas, the eyes should be thoroughly washed out. As good a solution as any is sodium bicarbonate, and this was used as a routine in our gas hospitals, of which we had several in the areas back of the Argonne. In the later stages, when the soldier is sent back to the Evacuation or the Base Hospital, frequent bathing should be given with a lukewarm solution either of boric acid, salt solution or one per cent. sodium bicarbonate. Following this, a drop of oil should be instilled into the eye. The oil which we found the least irritating was liquid albolene. Theoretically, a vegetable oil, such as castor oil, should prove to be of value, as it dissolves the mustard gas. In practice, however, we found it rather more irritating than the liquid albolene and gave it up. For the milder cases, this treatment will suffice.

When, however, there are much blepharospasm and irritation, atropin should be always used, for this indicates a greater or less involvement of the cornea. If a one per cent. solution of atropin is used once or twice a day, it will usually keep the pupil well dilated. Occasionally, however, one must use it in larger amounts. A shade should always be supplied, or a pair of dark glasses. The eyes should never be bandaged. Agreement on this point is unanimous. In the British Service and in our own, a great deal of trouble was experienced from the bandaging of these cases. In a number of cases where secondary infection of the cornea took place and the vision was permanently impaired, or the eye was even lost, we felt very strongly that bandaging contributed materially, if not entirely, to the bad results. Our experience is borne out by Warthin's experiments.

In those cases where secondary infection of the conjunctival sac took place, a weak antiseptic solution was found to be of benefit. Most often we used argyrol or protargol. If an actual septic ulcer of the cornea developed, it was treated by the methods used in civil life. As the nutrition of the cornea is impaired, it is well to apply heat when corneal

ulceration occurs. The ulcer may be lightly touched with pure carbolic acid, and if necessary, a Saemisch section made.

Atropin should be continued so long as any corneal involvement in gas cases continues, and a shade or dark glasses should be worn as long as the pupil is dilated. As soon, however, as the pupil has resumed its normal size and the injection has largely disappeared, the patient, if his general condition permits, should be gotten out of his bed and should be sent outdoors into the light, and stimulating treatment should be applied if subjective photophobia and lacrimation still persist. Cold bathing of the eyes seems to be of value and a weak solution of sulphate of zinc twice a day. It is always wise to give the patient in this stage some sort of light duty. One should be always on the watch to combat the beginning of a neurasthenic tendency. These patients always recover with normal vision, unless a severe involvement of the cornea has taken place. In the treatment of gassed eyes cocain should not be used, as it tends to damage further the corneal epithelium.

Reference has been made to a large series of cases seen while serving with the British Expeditionary Forces in which, to our knowledge, no permanent damage of the eyes took place. This may be laid to several factors. In the first place, we got our cases early, being little over fifty miles from the front, and British transportation after three years of war had become wonderfully organized. Secondly, the eyes received immediate attention on reaching us, and treatment was faithfully carried out by an exceptionally strong and experienced nursing staff. The natural deduction is, and in this our British colleagues agree, that with proper handling of cases mustard gas should very rarely cause permanent visual damage. The majority of gassed cases tend toward spontaneous early and complete recovery. Visual damage is seldom seen, and complete blindness must be one of the very rare results.

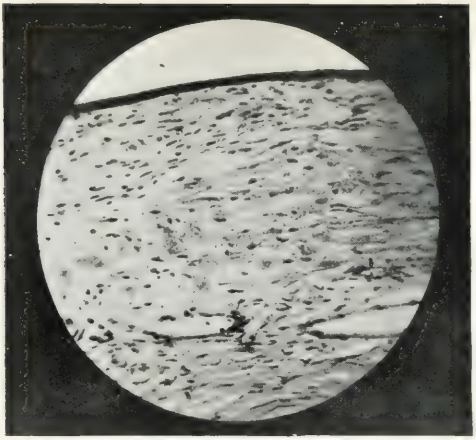


FIG. 1.
Granular exudate beneath bulbar conjunctiva, probably corresponding to solid white exudate.

FIG. 2.
Corneal epithelium diminished in thickness. Cells are contracted and stain deeply.

FIG. 3.
Thinning of corneal epithelium. Bowman's membrane laid bare, cellular exudate in the substantia propria.

Sections of Gassed Eyes Kindly Loaned by
COL. W. T. LISTER, R.A.M.C.

PATHOLOGY.

In the American Expeditionary Forces up to the time of the armistice, we had no provision for the pathologic examination of eyes, though this was planned and would have been instituted had the war gone on. The British were more fortunate, for, although they did not succeed in obtaining material from those cases that died in the first few days after being severely gassed, they succeeded in obtaining eyes gassed a fortnight or so before; and I may be permitted, therefore, to quote from one of Colonel Lister's reports:

"The pathologic examination of eyes which have been gassed show changes in the corneal epithelium, the substantia propria, and in the conjunctiva. Sections of the cornea show definite changes in the epithelial layer. The deeper cells, instead of being columnar, are flattened. The thickness of the whole layer is diminished, so in passing from the periphery toward the center of the cornea it gradually thins down till only a single layer of flattened cells is left, while in parts this also is lost and Bowman's membrane is left bare. The substantia propria in some cases shows infiltration of round cells between the layers, as is found in other cases of deep inflammation. In the conjunctiva over the sclerotic, granular masses have been seen in the subepithelial tissue, which probably correspond with the solid white exudate seen in the interpalpebral aperture."

At the close of hostilities, the American Expeditionary Forces was fairly well equipped to care for gassed eyes. The medical officers at the various gas hospitals were sufficiently acquainted with the lesions which could occur to be able to give those cases proper treatment. At most of the mobile and evacuation hospitals, there was a trained ophthalmologist who had either had some personal experience in the treatment of gas, or who had been instructed in that work by personal visits from the consultants and by means of circu-

lars which were sent around from time to time. The same also applied to practically all of our base hospitals in France. Bandaging of the eyes was strenuously combated. Medical officers and the medical personnel on hospital trains should also be instructed in this work.

When gassed cases are evacuated at base hospitals to convalescent camps, it is important that they should be grouped at places under trained medical supervision, in order that those cases with irritable conjunctivæ should be brought into condition to be sent back to duty at the earliest possible moment. Some of these cases may be held almost for a month under supervision, when with proper treatment they could be sent back to duty in a comparatively short time.

EXPERIMENTAL WORK ON MUSTARD GAS.

In this country recently a series of very important observations on the effects of mustard gas on the eyes of animals have been made by Warthin and various others. In these experiments, mustard gas was applied directly to the center of the cornea with a fine pipette and in uniform minute droplets. In another series, animals were exposed to the vapor of mustard gas in varying concentrations and time. These experiments were carried out mostly on dogs and rabbits.

Exposure of fifteen minutes to a concentration of 1:20,000 was found to cause a burn of the same severity as from a standard droplet applied to the center of the cornea. Fifteen minutes after the mustard gas was applied, congestion of the superior palpebral conjunctiva was noted. In one hour the conjunctiva had become edematous. From then on, there was progressive increase in the edema until there was a ring of swollen conjunctiva about the cornea.

Corneal changes took place in five to six hours. They consisted first in faint clouding, roughening, and irregularity. There was an increasing seropurulent exudate. Photophobia and lacrimation were marked.

In eight hours the cornea became porcelain white and there were irregular rounded areas without epithelium. Minute subconjunctival hemorrhages were seen. By the second day, the edema was marked. The denuded area of the cornea increased in size, and there was a large opacity in the lower half of the cornea, which often showed an opaque band running horizontally. The lids were sealed by secretion. Hypopyon was sometimes seen.

During the second week, the exudate decreased somewhat, but the corneal opacity remained unchanged. The lids, however, became unsealed.

During the third week, the lesions were slowly progressive, but a sluggish reparative process began. Ectropion of the lower lid was noted.

In the artificially produced burns from mustard gas, Warthin found that the changes varied enormously according as to whether the conditions were treated or left untreated. If no treatment were given, the lids sealed and exudate accumulated. Purulent panophthalmitis often developed within three weeks, and within six weeks the eyes may be destroyed. If a larger dosage is used and the eyes remain untreated, panophthalmitis may develop more quickly. Panophthalmitis was due entirely to secondary infection, which occurred after several weeks in untreated cases even after slight gassing and much more rapidly after heavier doses. Warthin found that staining with fluorescein took place very early after the application of mustard gas to the cornea. These observations show conclusively the damage which may be done by the bandaging of the eye.

A large number of eyes were examined microscopically. The earliest changes noted in the cornea consisted of pyknosis, contraction of the epithelium and of the substantia propria, most marked at the corneal vertex extending down to Descemet's membrane. This is followed by a loss of nuclei until by the twelfth hour the corneal vertex shows

complete necrosis, the necrosis often extending from the limbus nearly to the scleral junction. Desquamation of the dead corneal epithelium begins in about five hours. Polynuclear infiltration of the sclerocorneal junction begins in five to six hours. The earliest signs of regeneration of the substantia propria of the cornea were noted at the end of sixty-five hours. The new formation of blood-vessels into the limbus was well marked at the seventh day. Slow repair of the cornea continued for several weeks with development of a highly vascularized corneal cicatrix. Marked changes in the corneal thickness occur as the result of separation of the lamellæ, edema, cellular infiltration, and fibroblastic proliferation.

The severity of the corneal lesion is in direct proportion to the concentration of the gas and the period of the exposure. The necrosis of the conjunctiva is less in degree than that of the cornea or of the skin surfaces of the eyelids. The primary necrosis rarely extends beneath the basement membrane of the palpebral and bulbar conjunctiva, except at the palpebral margin. There were shallow ulcers at the palpebral margin. There was extreme edema of the subconjunctival connective tissue, most marked in the bulbar conjunctiva near the scleral sulcus and in the palpebral conjunctiva of the upper lid. Petechial hemorrhages were of frequent occurrence in the subconjunctival connective tissue. Regeneration of the conjunctiva takes place rapidly and is followed by permanent thickening. Iritis and iridocyclitis are common occurrences at about the third to sixth week in the uncared-for cases as the result of secondary infection. In the cared-for cases, no changes were observed in the iris, ciliary body, choroid, retina, and optic nerve except congestion and edema. There was increased functional activity of the lacrimal gland, with subsequent overuse atrophy and subsequent hypertrophy. Warthin regards the relatively slight penetration into the subconjunctival tissues as due to the

protection afforded by the moistness of the surface and lacrimation.

For treatment Warthin recommends a one-half of one per cent. solution of dichloramin-T in chlorcosane. His experiments show that this solution if applied to the eye before exposure has a definite prophylactic action, and when applied to the eyes before and after exposure the resulting lesions are much less severe. Its use is indicated after exposure to gas for its germicidal action and the prevention of secondary infection.

Warthin concludes that the action of mustard gas on the conjunctiva is essentially the same as that on the skin. The conjunctiva is less susceptible to its action. Even in the milder cases of conjunctivitis, localized roughness or irregularity in the conjunctival surface may persist for weeks as the result of localized edema, hyperemia, and cellular infiltration.

As was mentioned before, Victor Meyer stated that he had produced a metastatic conjunctivitis from the injection of mustard gas. This statement was confirmed by Haldane. In an attempt to verify these statements, Warthin experimented on eight animals. In none of them did conjunctivitis develop.

Great difference in individual susceptibility has been found by a number of observers. It was tested by Marshall, Lynch, Smith, and Williams, of the Medical Division of the Chemical Warfare Service. They found a decided individual difference in the skin reaction to mustard gas independent of changes in sensitivity due to sweating. About 20 to 40 per cent. of the white men tested showed a certain degree of resistance; while 78 per cent. of negroes tested showed a similar resistance. About 2 per cent. of white individuals showed a hypersensitivity; no hypersensitive cases were found among negroes. Individual differences in sensitivity were also noted in animals. It is not improbable that the hypersensitivity to mustard gas may occur in those cases which show the

picture of a persistent thymus and characteristic lymphoid hyperplasia.

My thanks are due to Colonel W. T. Lister, C. M. G., Ophthalmic Consultant B. E. F., for very kindly sending me his "Report on the Effects on the Eyes of Irritant Gases Used in Warfare," also for the Atlas on Gas Poisoning prepared by the Medical Research Committee, and for various histologic specimens of gassed eyes.

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DISCUSSION.

DR. F. H. VERHOEFF, Boston: At Camp Devens I saw a number of the gas cases when they returned to this country. The eyes were, in many cases, still in a much irritated condition. Sometimes they quieted down, but the slightest irritation caused photophobia and prevented the use of the eyes. In some cases simple exposure to cold was sufficient to cause irritation. In a few cases there was permanent corneal involvement, with vision down to 20/100; and there seemed no prospect that vision would get better. I found nothing that would relieve this irritation. Weak cocain solution made them worse, if kept up for any length of time. Castor oil seemed to produce a little benefit in some instances, but I finally decided that they did better without treatment.

The question arose whether the eyes that had been badly exposed, even without corneal involvement, would ever reach a normal condition. It seemed to me possible that the men would have more or less trouble all their lives.

DR. WALTER B. LANCASTER, Boston: Dr. Derby spoke of the importance of starting these men right, by not letting them think that their trouble would be serious. I have seen many returned soldiers with refractive errors or asthen-

opia who laid all their troubles to having been exposed to gas. There are two lessons to be drawn from this. One Dr. Derby mentioned is the importance of starting the patients right, so that they will not fear the loss of their sight or have permanent disability; and the other is that similar things occur in private practice. Very slight injuries happen, and all the troubles of the patients are attributed to these injuries; while the truth is that the injury was only an insignificant factor, and simply started the ball rolling, the trouble being kept up by the patient's attitude toward it.

DR. ALLEN GREENWOOD, Boston: It might not be necessary to discuss this paper, in view of the fact that we hope not to have to treat these cases again; but there are several points that Dr. Derby has brought out that I wish to emphasize. One is the very early treatment of these cases. We made efforts to have them treated within five or six miles of the front line. The gas service was under the charge of a special medical officer who sent out circulars to the regimental surgeons and medical officers at the front, calling attention to the points that Dr. Derby has mentioned, especially the non-use of bandages. I saw one case that had come from the front with both corneæ destroyed, and the patient said that a bandage had been put on both eyes and left there for three days during transportation. Colonel Derby has told you that he went to one hospital and removed many bandages. In our circular we advised lack of bandaging, early treatment, and directions not to hospitalize these cases. They were prone to become hospitalized, and I saw one man who had been in the hospital for three months, in a dark room, and was considered to be in bad shape. The only treatment that I advised was to send him out doors the next morning, without colored glasses or eye-shade, to work in the garden, and this treatment produced a cure within twenty-four hours, showing the psychic influence on the condition. In the severe cases the effect of mustard gas is similar to any caustic burn. Those who have seen mild ammonia burns, with the whitened conjunctiva lifted up around the cornea and the usual corneal involvement that follows, will have a good picture of these cases.

I think that it is well, perhaps, to call your attention for a

moment to the really severe results possible following the use of gases in war, and to do this I have only to mention one experience. That was in an evacuation hospital six miles back of the firing line, where, early in the spring of last year, there were brought in, during one afternoon, 150 men who had been badly gassed. They took out 35 dead bodies from the ambulances. All had been badly gassed by the phosgene and mustard gas combined. Their eyes were carefully washed and treated as Dr. Derby suggested, and this early treatment prevented the severe results that might otherwise have occurred.

Dr. Edward Jackson, Denver: As bearing on the pathology, I might mention a case that was accidentally exposed in the manufacture of gas in this country. I saw the patient about seventy-two hours after exposure. The trouble with the eyes had appeared about twenty-four hours after the probable time of exposure. The point that I want to mention is that there was a pretty free discharge from the conjunctiva, which practically consisted wholly of epithelial cells. There were no polymorphonuclears and no bacteria whatever were found. The mass of the discharge was young epithelial cells.

Dr. Nelson M. Black, Milwaukee: Dr. Derby and Dr. Lancaster have called attention to the fact, in treating gassed eyes, that it is important to start the men right, with the idea that they are not going to lose their eyesight. Colonel Derby hit upon an admirable plan. The men felt that they must have some protection from the light. As eye-shades were practically unobtainable, and dark glasses few and far between, Dr. Derby suggested that the blue paper that comes around absorbent cotton, be utilized to make eye-shades. The result was that with this protection many men who wanted to keep their heads down and their hands over their eyes would go out into the light they had formerly been so afraid of. In a very short time, being guyed by the rest of the men of their acquaintance for wearing this shade, it would come off, and they would be on the high road to recovery.

Dr. George S. Derby, Boston: There are two brief points that I wish to mention: First, in regard to what Dr.

Fig. 1.

Verhoeff said, that experiments made under the direction of the medical war service showed that it is not improbable that hypersensitivity to mustard gas may occur in cases showing a persistent thymus and characteristic lymphoid hyperplasia; second, eye-shades or dark glasses must be worn so long as the action of the atropin still exists. You cannot tell a man to take off the shade until that has disappeared.

PRIMARY TREATMENT OF WAR INJURIES OF THE LIDS AND ORBITS.

ALLEN GREENWOOD, M.D.,
Boston, Mass.

In considering military ophthalmic surgery of the lids and orbits it is best to divide the subject into primary and secondary surgery of these regions. The latter, of course, includes the large subject of plastics and orbit restorations. The author has, therefore, accepted for his portion of the subject the primary surgical methods to be taken where there has been a wound of the eyelids or of any part of the orbit.

Gunshot Wounds of the Eyelids.—Experience with such wounds in the recent world war has shown that, as far as possible, such cases should come under the care of an experienced ophthalmologist. The regular surgeon has been taught by the experiences of the war to handle the bulk of his gunshot and shell wounds by following the plan of early and extensive débridement, overlooking the fact that infection of the eyelids following primary suturing is extremely rare, and in the few cases where it occurs is easily controlled. As the result of the following out of such methods by the general surgeon many men have had extensive removals of torn and injured eyelid tissue, to their future detriment. During the author's service in France several circulars were sent out call-

ing attention to the necessity of preserving as much of the eyelid tissue as possible, and urging the primary suturing of all eyelid wounds whenever practicable, with the utmost accuracy.

The following is taken from Circular No. 1.

"*Orbital Injuries.* –A small foreign body in the orbit not easily accessible should be left unless cellulitis develops. Larger bodies should be removed, avoiding injury to muscles and nerves.

Orbital cellulitis requires free drainage.

Perforating wounds of the orbits by bullets or other missiles should be treated symptomatically. Lagophthalmos from the extreme exophthalmos often seen in such cases or the lagophthalmos resulting from facial palsies should have the lids sutured together to protect the eye if there are any signs that the cornea is likely to become involved."

Extract from Circular No. 2.

"*Wounds of the Eyelids and Adjacent Parts.*—Extensive débridement of wounds of the eyelid and adjacent structures is seldom necessary, it being of greatest importance for the proper function of the eye that every effort be made to save tissue in wounds involving the lids and adjacent structures. Primary repair of almost all these wounds should be attempted, and this will alleviate the necessity of much secondary plastic work. In very extensive wounds it may be necessary to insert a small drain in one corner. Special attention is called to the necessity of early and accurate repair of wounds of the lower lids, with special reference to those involving the inner portion.

"*Orbital Wounds.* Orbital tissues should be conserved in doing enucleations and evisceration. An orbit should never be packed, but where an orbital cellulitis exists, a small drain is often advisable. An evisceration leaves a very good stump, and this operation should be the one selected for a ruptured and collapsed eyeball and for a panophthalmitis.

It should be the operation of choice where a good clean enucleation, with implantation of glass ball, is not practicable. Glass balls may be obtained on requisition from the Inter. Med. Supply Depot No. 3."

Ophthalmic surgeons are always provided with fine needles, and, with their special equipment of instruments and knowledge of lid anatomy, are better fitted to handle these cases, it being difficult, with the coarser instruments ordinarily used by general surgeons, to make a neat and careful readjustment of the cut conjunctiva. Especial care should be taken with tears and wounds of the lids, particularly the lower lids, which involve the inner angle. This is the most common seat of tears, and any lack of accurate reapposition of the tissue is sure to result in an unsightly deformity, the complete removal of which, by later plastics, is very difficult. Such a careful reapposition of lid wounds is just as important where destruction of the eye is included in the injury, so that the patient, with an enucleation or evisceration of the injured eye, may also have a good socket.

A good many cases were seen in France where both lids had been badly cut and the eye destroyed, for the treatment of which an enucleation had been performed by removing the remains of the eye, including a good share of the conjunctiva, and no attempt made to repair the cut lids. Healing by granulation had, of course, taken place and the patient had to look forward to a long series of plastics which could easily have been prevented by early suturing of the lids and conserving the conjunctiva.

Ophthalmologists will readily appreciate that the most careful suturing of the conjunctiva must precede, or go hand in hand with, suturing of the skin surfaces. Small tags of tissue, which are palpably entirely devitalized, can, of course, be removed, but it is astonishing how little of such tissue is found even after extensive shell wounds of the lids.

Cases are occasionally, though very rarely, met in which

there is entire destruction of one or both lids. In such cases any attempt to do a primary plastic is inadvisable, but the tears extending into the surrounding tissues should be carefully brought together to reduce subsequent granulation to as small a region as possible. For the suturing of the conjunctival cuts and tears and the skin portions of the lids the author is in the habit of using a fine curved needle, threaded with fine silk. For the tears extending into the surrounding skin tissue silkworm-gut has been preferred.

The restoration of the line of lashes can best be brought about by placing a suture as close to the roots of the lashes as possible, both anteriorly and posteriorly. These two sutures, of course, require a very fine curved needle. This will also tend to prevent the notching up of the lid margin which is so frequently seen after a cut involving all the layers of the lids, and it is an advantage to include a portion of the cut edge of cartilage in the conjunctival sutures if the cartilage has been cut completely through.

Orbital Injuries.—Injuries to the orbits, and their surroundings, during times of military activity, are, of course, very frequent and occur in many degrees and varieties. Penetration and perforation of the orbits by foreign bodies, particularly bits of shrapnel and bullets, are frequently seen.

The majority of the penetrating wounds of the orbit are complicated by the presence in the orbit of the foreign body. Many small bits of shrapnel find their way into the tissues behind or around the eye, where they become encapsulated and give rise to no serious consequences. So true is this that it is unwise to make any extensive exploration for small foreign bodies located in the orbit. If the foreign substance has carried infection into the orbit, an orbital cellulitis may result, which will require drainage, and in the process of draining the foreign body may be extruded. The temptation, however, is sometimes very great to explore for these small

particles, but it is much wiser for the sake of the patient to resist the temptation and not interfere surgically.

In cases where a larger foreign body has penetrated the orbit there is usually such a considerable amount of destruction of tissue that the foreign body can be removed without adding to the already existing trauma. In many cases the foreign body has passed through the globe, tearing it to pieces, and become lodged behind the eye. In all such cases a careful *x*-ray localization should be carried out to make sure that the bit of shrapnel has not perforated the roof of the orbit and become lodged in the brain, thus putting the case in a class with those requiring the skill of the brain surgeon.

Perhaps the class of orbital injuries which have excited the greatest interest have been those which have occurred in considerable numbers, where the bullet, passing behind the globe or through the bony tissues surrounding it, has produced more or less severe injury to the globe by extension of the trauma, without actually coming into contact with the globe itself.

The world war has produced a great many choroidal ruptures, macula holes, hemorrhages, severed optic nerves, and other interesting ocular findings.

Quite a proportion of the men who are at present in the class of the battle blind have had their blindness result from the passage of high velocity bullets through the orbital apices. Very little can be done for this interesting group of orbital injuries. The application of ice compresses will often lessen the amount of hemorrhage and the subsequent reaction. Where there is a large clot of blood in the orbital spaces, causing an extrusion of the eye, it is frequently necessary to sew the lids together to protect the cornea from exposure keratitis. Lagrange has reported and illustrated a large number of these interesting concussion and contusion cases, and the following case is a very good illustration of this type.

CASE REPORT.—Pvt. D. J., No. 1243786. Aged eighteen. In army one year. Admitted to Base Hospital No. 115 September 13th.

Chief Complaint.—Drooping of upper right eyelid and blindness of the right eye. Family and personal history negative.

Present Trouble.—On August 11th received gunshot wound of head, right frontal region; was unconscious for four hours, after which he was hazy for several hours. At this time he noticed that the right eye was swollen and that he could not open the eye. On raising the lid he noticed that the eye was blind. Six hours after the injury he had an operation. Following this he had severe headache for three days. Since then he has had no trouble except the present eye trouble.

Notes from Evacuation Hospital.—Fracture of skull, right frontal, penetrating orbit, with loss of bone substance and orbital fat.

Operation: Foreign body removed from orbit, dura exposed, orbit cleaned out, and skin edges sutured.

Present Findings.—Head wound healed; loss of bone substance three cm. in diameter up and back from the outer canthus; paralysis of frontalis muscle within scar boundaries, also loss of sensation here. Mental and physical examination otherwise negative.

Eye Examination.—V.R.E., L. P. up and out. V.L.E., 20 20. Right eye: Complete ptosis, paralysis of superior rectus; external examination otherwise negative. Fundus: Few fine floating vitreous opacities, media otherwise clear; disc round, rings very distinct; cup present and deep; lamina cribrosa present; whole disc slightly pale, more marked temporally. Arteries slightly smaller in caliber than normal; reflex stripe present. Veins normal in caliber and regular, except where the superior temporal makes an unusual loop just above the macular region. The macular region shows a very interesting oval lesion, long axis 180. This lesion is about two-thirds the size of the disc, with the border distinct and regular. (Fig. 1.) This area appears to be slightly depressed, the lower border showing a deeper edge than that above. The lesion is bright red in color; near the lower border there are many small brown pigment spots, and

situated in this region are four small glistening spots resembling cholesterin crystals, also a few slightly larger grayish bodies, which are probably hyaline bodies. Extending from this lesion up to the superior temporal vein there can be seen a large number of small, irregular, brownish pigment spots, situated in the retina, under the superior temporal vein. These are most conspicuous, some lying along the wall of this vessel. Near many of these pigment spots there can be seen some shining, veil-like masses which are probably an increase of glial tissue. The area of pigment extending directly up to the temporal vein is about one disc diameter broad. The retina elsewhere has a normal appearance. Left eye normal.*

In a discussion of military orbital injuries one is impelled, from his experience, to devote a few paragraphs to the early treatment of those devastating injuries which involve the eyeball, the lids, and the orbit. So many of these cases have fallen into the hands of the general surgeon, particularly prior to the time that an ophthalmologist was attached to all the principal hospital staffs, that too much stress cannot be laid upon the necessity for treating these wounds conservatively. The author has repeatedly seen cases where a perforating wound of the orbit has injured the eye sufficiently to demand its removal, and practically an exenteration of the orbit has been performed.

It is astonishing how much tissue can be preserved in an excessively devastating injury of the orbit and its surroundings.

In those cases where the eye is hopelessly lacerated an evisceration should be done, simply removing the torn pieces of cornea and limbus, including the ciliary body, and cleaning the retina and choroid away from the remnants of sclera. This frequently will leave a very useful stump, where, if attempts are made to do a complete enucleation or to re-

* I am very much indebted to Captain Burkholder, of Base Hospital No. 115, for this excellent painting of the fundus, and to Lieutenant Clay for his description of the case.

move all the injured tissue, as the general surgeon is prone to do, a very unsightly orbit may be left.

If, in these devastating injuries, an orbital cellulitis does develop later, it can be handled very easily, even in cases where the eyeball is intact, for drainage from the lower part of the orbit will in almost every case yield perfectly good results. The slogan of the ophthalmologist in treating lid and orbit injuries should always be to remove as little tissue as possible and assist nature in the process of healing, with always in view the future cosmetic appearance of the patient.

DISCUSSION.

DR. GEORGE S. DERBY, Boston: I should like to emphasize one point that Colonel Greenwood has made, that is, leave foreign bodies in the orbit alone, unless for some reason you have to go after them or unless they are of large size. In France, a great many were left in, and the men are apparently perfectly well. The orbit is a bottomless pit, and it is often hard to find even a fair-sized body, and you often cause considerable damage in searching for it.

DR. GEORGE E. DE SCHWEINITZ, Philadelphia: Dr. Greenwood's reference to holes in the macula, and the illustration which he has exhibited, suggests a further note on this lesion. If I am not mistaken, Colonel Lister, of the B. E. F., in one of his papers states that holes in the macula are comparatively infrequent in the concussion injuries of warfare, contrasted with those which occur in civilian practice. That has not been our experience among the wounded in our own forces. Of 26 concussion injuries recently examined, I found five typical holes in the macula—a fair proportion. I have seen many others, and a number have been reported to me from various "eye centers." Dr. Derby will, I hope, give us his experience in this regard while serving with the British Forces.

DR. GEORGE S. DERBY, Boston: I was rather surprised at Colonel Lister's statement; because, working in No. 83 General Hospital, I saw more holes in the macula than I had ever seen before.

DR. EDWARD JACKSON, Denver: In relation to the frequency of "hole in the macula," I would say that the examination of recruits for our army, where such examinations included a careful ophthalmoscopic examination, showed that holes in the macula were much more frequent than the literature previously published would have led us to believe. I have a considerable series of cases that were found in that way. The most of these patients could give but little history of the cause of the hole. In many cases the injury had probably occurred in early childhood; and the patients had never consulted an ophthalmologist or had their eyes examined with the ophthalmoscope.

DR. NELSON M. BLACK, Milwaukee: Dr. Greenwood mentioned the fact that many of the men requiring restorative work about the orbit come back with bad conditions of the tissues in this region. I think this can be explained to a certain extent by the fact that in the early days of the work in our army overseas, *i. e.*, when the evacuation hospitals were first organized, the ophthalmic section of the Surgeon-General's office was not allowed to attach ophthalmic surgeons to them. Later on permission was given to do this; and, in ignorance of the conditions existing, the ophthalmic section did not select the most highly qualified ophthalmic surgeons for this work, which was a great error as the primary surgery is what counts in the end. As the result, in a large number of instances, an attempt was made at removal of the eye by the general surgeon in the manner Dr. Greenwood has described. Another factor was that in the evacuation hospitals the percentage of eye wounds being relatively small, the eye man was not given a position on a general surgical team. He was given various other comparatively unimportant duties to do. Then, when an eye case came in, a chief of the surgical team would ask for the eye man. A considerable amount of time was spent in finding him. When found he had to get his instruments ready and that took time. As the result, the surgical chief decided against sending for him, and attempted to enucleate the eye himself.

Later, the suggestion was made by Colonel Greenwood that the ophthalmic surgeon be made the assistant to the general surgeon on a surgical team, and that all eye cases

be directed to this particular team, the general surgeon assisting the eye man in eye cases. This change was made late, and did not become generally effective. However, a great many commanding officers acted on Colonel Greenwood's suggestion. Colonel Stark issued an order in the Third Army, that the eye man should be a member of a surgical team and assistant to the general surgeon, so as to be on hand at all times. When this particular team was not on duty the cases that came in with eye injuries as well as other injuries received general surgical treatment and were sent to the ward. Then, when the team with the eye man attached to it came on duty, the soldiers' eyes were attended to.

DR. ALLEN GREENWOOD, Boston: The suggestion of putting an eye man on the surgical team was made by Dr. Black and not by me. I was glad to adopt his suggestion which seemed exceedingly wise; and it worked out well, particularly when Dr. Black or Dr. Derby was a member of the team. The lack of ophthalmologists in the evacuation hospitals was a grave one in the early days. All of the consultants at Headquarters had to go to the front and take positions in evacuation hospitals, and go from one to another during the stress of work to try and cover these cases.

I want to take a minute to draw a word-picture of an evacuation hospital in time of stress. During the height of the Argonne offensive I went to the most forward of the evacuation hospitals, at the tip of the forest, which had been opened only two days. It had been raining a week, was still raining when I arrived, and the roads were a sea of mud. The hospital was in an old château, with tents arranged around it, and practically every ambulance wheel went up to the hub in the mud. The nurses and officers were wearing rubber boots, and those that were there to help out or to see how things were going wore overshoes. I entered the hospital at three o'clock in the afternoon. Every ward was crowded. Ambulances were coming at the rate of one every two or three minutes. The officer who had charge of the shock work had four tent wards filled with shock cases. Among these were ten or fifteen men whose faces were partly destroyed. I wish I had the gift of easy speech and the

ability to draw word-pictures, so as to draw for you a real picture of that hospital—the rain coming down in torrents, the sea of mud, the shock ward filled, a little heater at the foot of each bed, with the men looking as if at their last gasp, ambulances coming in every two or three minutes, and the drivers exhausted.

About thirty miles away we had a special hospital for head cases; but it seemed a crime to ask the drivers and patients to go the extra thirty miles to reach this eye hospital. This shows the necessity of having a competent ophthalmic surgeon right at the spot to take care of such cases. It is a picture that will always live with me, and I have tried to give you some idea of what these hospitals are like under such conditions.

PENETRATING AND PERFORATING WOUNDS OF THE EYEBALL WITH DIAGNOSIS AND TREATMENT OF RETAINED FOREIGN BODIES.

WILLIAM T. SHOEMAKER, M.D.,
Philadelphia.

Wounds penetrating or perforating the eyeball, as seen during the war, present a number of interesting lines for discussion. If the eyeball is sufficiently destroyed from rupture removal, incomplete or complete, is necessary and, if vision is totally lost from hemorrhage or intraocular damage, removal may be advisable. In these cases the only question is the advantage or disadvantage of one of the several methods and the selection of the best method for that particular case. If the eyeball is not destroyed, but contains a foreign body, discussion might be endless upon the various procedures to be practised. First, a determination of the character of the foreign body, whether magnetic or non-magnetic; second, its size and location as shown by the *x*-ray; third, if magnetic, the best way to attack it, whether

by the anterior or posterior route, the best sort of magnet, and the best technic; and fourth, if non-magnetic and otherwise inaccessible, shall it be allowed to remain or shall the eyeball be removed; in other words, judgment on the dangers of sympathetic ophthalmia. The totally destroyed eyeball, and the majority of them with us were in this class, has been well described by Colonel Lister and others. It presents little interest, and offers but little opportunity for anything but ordinary skill and judgment. Such eyeballs were often primarily eviscerated, and the accompanying conditions were mostly compound comminuted fracture of the orbital and other bones of the face and skull, laceration and destruction of the lids, conjunctiva, etc. Brain substance was frequently lost through a fracture of the orbital roof, and often enough the ethmoid sinuses, the antrum, and the orbit were thrown into a common cavity. Swelling and infiltration were intense, and the only practical procedure was a clean-up operation. The foreign body, generally near at hand, was sometimes far removed from the domain of ophthalmic surgery. For example, in one case a large piece of shrapnel had passed from before backward, completely through the eyeball and orbit into the brain, and rested there beneath the cortex in the temporal lobe just in advance of the ear. By a partial exenteration of the orbit and the aid of an ordinary large nail as a tip introduced through the wound of entrance, I was able to recover the foreign body with the hand magnet. The patient made a good primary recovery and went to "Blighty," apparently little the worse for the wear. What has happened since I do not know.

Whenever possible, I enucleated completely what was left of the badly ruptured eyeballs, with the feeling that recovery was more quickly reached in this way than by allowing the eviscerated sclera, or any part of it, to remain. Colonel Lister favored the retention of a button of sclera

next the nerve, to avoid opening the nerve-sheath. While fatal meningitis and sinus thrombosis following enucleation for panophthalmitis is possible, and theoretically a danger, it must be an exceedingly rare occurrence.

Noyes* concludes that "while a small risk of life is incurred by enucleation, about 1 in 4000, the supposed increase of risk by the existence of suppurative panophthalmitis is not so far justified by the facts as to bar its performance under these conditions. Neither when proper indications arise need we on this account hesitate to do the operation."

Kontrowitsch reviews the literature to 1912 and concludes that, on the whole, enucleation is a fairly safe procedure. Darrieux holds that in traumatic panophthalmitis enucleation is the operation of choice, while in other forms of panophthalmitis that operation offers no greater danger than any other operative procedure.

I have seen one case of suppurative meningitis following enucleation for panophthalmitis. That was nineteen years ago. And more recently I had a case of beginning sympathetic ophthalmia following enucleation in which a button of sclera had been allowed to remain. The condition promptly disappeared when the sclera was removed. To this case, however, belongs an explanation. The eyeball had been imperfectly enucleated, and the operator had cut through the sclera of a collapsed eyeball instead of through the nerve. Naturally, the stump contained portions of retina and choroid, which may well account for the subsequent trouble. It emphasizes, however, the importance of thoroughly disposing of all but sclera when we eviscerate. In my opinion complete enucleation in these cases is the preferable operation, irrespective of the septic or non-septic condition of the eyeball. It is important to conserve as much of the lids and conjunctiva as possible, as the end

* Textbook, p. 546.

results of such extensive palpebral, orbital, and bulbar injuries as occurred in the war are often most disappointing. Regarding the shattered fragments of bone it does not require much of an attachment for them to be usefully retained. Therefore, only the very loose and apparently totally detached pieces should be removed. In the treatment of these crude traumatisms I found dichloramin T in eucalyptol of the greatest value. It was used very freely, gauze soaked in it being loosely packed into all cavities and recesses, and all parts of the wound and its surroundings sprayed with it. Return of the tissue toward the normal was surprisingly rapid, and in no cases were bad effects noted.

The intraocular foreign bodies demand removal, when such is practical, as soon after the injury as possible, and with as little additional damage to the eyeball as necessary. Removal by forceps from the vitreous can scarcely be considered as practical, because, when successful, it is more a question of luck than skill. If large enough to get we might as well take the eyeball. The metallic substances encountered in these injuries were iron, steel, copper, lead, tin, brass, nickel, aluminum, mixed metals, and I presume others. Then, of course, eyes were injured by stone, gravel, glass, china, wood, or anything in the neighborhood. While but two of these substances are magnetic, I would say that fully 50 per cent. or more of my cases of intraocular foreign bodies were in this class. As to this point, there is a wide difference of opinion, based on the personal experience of different workers, and the true percentage value of the magnet can only be reached later by a careful study of innumerable records. In this connection mention is made of a remarkable statement from L. Vernon Cargill (1915) that he found the electromagnet of no use in either the South African or the present war. He had but one case of magnetic foreign body.*

* Trans. Ophth. Soc. United Kingdom, 1915.

As is well known, the eyeball was more tolerant to metals, which became more or less sterile in transit, than to foreign bodies secondarily projected from the ground or surroundings. Injuries from stone and gravel, sand, etc., were as usual particularly disastrous.

The *x*-ray, with a certain amount of localization, was essential. I say certain amount because, if the foreign body could be definitely located within the eyeball, its mathematically exact position made little difference in many cases, particularly of those in the vitreous, and, according to Whitehead, 75 per cent. of all intraocular foreign bodies are in the vitreous. Such a diagnosis was in most cases sufficient, but in some cases a more exact localization was very desirable. The British hospitals were wonderfully equipped in the eye service, thanks to Colonel Lister, and excellent localizations by the Mackenzie-Davidson method could always be obtained without too much trouble. Furthermore, a giant magnet, mounted in a motor ambulance, was always anxious to travel anywhere in the area if needed. No. 16 General Hospital, B. E. F., staffed by Pennsylvania Base Hospital 10, was weak on *x*-ray localization, but it had a very satisfactory hand magnet that could recognize iron or steel if given a chance. The practical way of determining whether or not the foreign body was magnetic was to cautiously try the hand magnet near or against the eyeball. This can be safely done if the eyeball is strongly rotated and the magnet first approached near the equator, and this zone tried out in all portions. If magnetic, the patient will unerringly feel a slight pull or at least a sensation. This is true of even very small foreign bodies, and for obvious reasons is a much safer procedure with a small than with a giant magnet. If the eyeball contained a visible open wound of entrance, immediate application of the magnet tip in the wound, irrespective of its position, was all that was necessary.

In my experience intraocular foreign bodies from war injuries are usually larger than those ordinarily found in civil practice due to industrial accidents. Hemorrhage and destruction are frequently overwhelming, and removal of the foreign body with retention of a blind eyeball is often all that can be expected.

Regarding the size of war foreign bodies, the statistics of Mora and Moreau* are interesting. Sizes were arbitrarily divided into three classes: small, weighing less than 0.25–0.30 gram; medium, 0.30–5 grams; and large, weighing more than 5 grams. Of a total of 486 injuries, 54 per cent. were by small fragments, that is, fragments weighing less than 0.30 gram.

The more important cases are those of small foreign bodies with a minute or closed wound of entrance, and with comparatively little hemorrhage or destruction. The foreign body has been localized and is known to be magnetic. It is in the vitreous, has passed through the sclera, and the anterior segment of the eyeball is uninjured. Will you remove it by the anterior route or by the posterior route? Will you use a giant magnet by the Haab method, or a good hand magnet; or a giant magnet used as a hand magnet? It is only fair to say that my experience has been almost entirely with the small magnets, notably the Parker and the Sweet, but I feel that either of these magnets, if properly used, can be relied upon to get almost any free magnetic foreign body within the eyeball. Of course, in war work the foreign bodies were practically all free from surrounding exudate. Nor is the actual strength or pull of a magnet alone the index of its efficiency. As shown by Lancaster,† the tip is an important factor. He found that a short, conical tip gave the best results. Sweet found, in testing the relative strength of the Haab, the Hirschberg, and his own mag-

* Brit. Jour. Ophth., February, 1917.

† Trans. Amer. Ophth. Soc., 1915.

net, that at 2 mm. distance his own was superior; at 5 mm., the Haab was stronger, but not markedly so; while at 10 mm. or more the large magnets were decidedly superior. There are other mysterious qualities of magnets which, if considered, should induce the surgeon in a given case to think more of the foreign body, its size, shape, and location, and the damage already done to the eyeball, rather than of the magnet alone. In other words, it is a mistake to feel that either the large or the small magnet is always the best in every case. The facility with which the small magnet can be handled, and the greater extent of the eyeball over which its tip can be applied, are distinct advantages and might in certain cases outweigh the advantage of greater power. It is perfectly true that those who habitually use the small magnet often wish for more power. Then is the time to call on the giant, but I would still stick to the posterior route for all bodies in the vitreous entering through the sclera. If the anterior segment of the eyeball is intact and uninjured I certainly would not injure it by dragging a foreign body from the vitreous into it, and then further injure it by taking the foreign body from it. We all know how the foreign body is supposed to come into the anterior chamber, but we also know that sometimes it is clumsy, and spoils a perfectly good lens or iris in its transit.

There would seem to be little danger in a sclerotomy and, while increased or serious hemorrhage might result, it is certainly not to be greatly feared. A posterior sclerotomy, when indicated, can be done with reasonable safety.

Finally, what is to be done with eyes containing non-magnetic bodies in inaccessible positions or foreign bodies we have failed to remove? The universal teaching a few years ago made the removal of such eyes obligatory. Not to do it was then malpractice. To do it now, *per se*, is practice equally bad. It all hinges on the question of sympathetic ophthalmia, and I know of no disease that has so

failed to make good during the war, with such unlimited opportunity, as has sympathetic ophthalmia due to the retention of a foreign body within the eyeball.

Parson's summary of the situation is very illuminating and helps a lot in deciding the proper disposal of these cases. The best theory for the disease, he thinks, is the transmission of an unidentified, specific organism by the blood-stream—the so-called metastatic theory. The site and nature of the wound are potent factors and not the mere retention of the foreign body. A sterile foreign body does not itself cause sympathetic ophthalmia, but secondary infection may do so. Any wound involving incarceration of the ciliary body or capsule is dangerous. He does not think that the mere retention of a sterile foreign body, whatever its nature, is of any importance at all so far as sympathetic ophthalmia is concerned.

Collins has also learned from experience that an aseptic foreign body implanted in the eye and chemically inert causes no disturbance apart from the wound of entry. When sympathetic ophthalmia arises it results from the nature or infection of the wound.

These statements from such authorities allay much of the former anxiety over cases in which we have failed to recover foreign bodies from the eye, and we must, as they indicate, pay more attention to the nature and condition of the wound of entrance.

In the discussion before the Royal Ophthalmic Society of Great Britain, where these statements were made, the question was asked, by what means one could know when sympathetic ophthalmia was likely to occur. Mr. Arnold Lawson gave in reply four very important factors to be kept always in mind:

1. Prolonged and intractable cyclitis or general uveitis, which goes on for week after week in spite of treatment.

2. The gradual supervention of an increasing lowering of

the intraocular tension, which is always accompanied by progressive failure of sight.

3. Continual photophobia and sympathetic neurosis affecting the other eye.

4. The condition of the blood count.

Hypotony he regards as perhaps the most important danger sign, and lays great stress on the importance of a considerable increase in the mononuclear cells in the blood (S. H. Browning).

T. R. Gifford believes mononucleosis to be a reaction of the body to a chronic inflammatory process in the eye of any kind, and concludes that its presence does not specifically indicate the presence or the imminence of sympathetic ophthalmia.

The danger of the three other conditions I think is well established, and in the presence of any one of them the indication for enucleation is clear. Nor should we forget that enucleation is only an absolute preventive if done before the sympathetic process, whatever it might be, is created. While there is a great tendency to refrain from destructive surgery, we might profit by the experience of the general surgeon in his treatment of malignant disease, and if an eye is blind or practically so, materially reduce its supposed valuation.

DISCUSSION.

DR. F. H. VERHOEFF, Boston: I think that there has long been a general misconception as to the danger of sympathetic ophthalmia resulting from retained foreign body, and I agree with the speaker that this danger is much exaggerated. During the past nineteen years I have examined a large number of eyes having the typical picture of sympathetic ophthalmia, and in not one have I found a foreign body. So far as sympathetic ophthalmia is concerned there is more danger, I think, in removing the foreign body than in leaving it in, because you produce additional trauma.

Regarding removal of the foreign body, I would say that

I prefer the anterior route, whenever it is possible to use it. You produce so little damage to the anterior parts of the eye that this need not concern us. When we attempt to remove the foreign body through the anterior chamber the foreign body frequently becomes caught in the iris and held by the sphincter. The natural tendency is to direct the pull of the magnet perpendicular to the sphincter, but this generally results in the foreign body becoming more thoroughly entangled. I overcome this difficulty by directing the traction almost tangentially to the sphincter at the site of the foreign body. The foreign body then glides under the sphincter and comes out in the anterior chamber. If it is caught very firmly I first pull it back a little toward the limbus. I have seen eyes greatly mutilated by attempts to get foreign bodies out that were caught in the iris.

DR. SAMUEL THEOBALD, Baltimore: Regarding the retention of foreign bodies in the eyes for many years, without producing serious consequences, I may mention a case of this character which came under my observation about forty years ago. A young man, as the result of the explosion of a test-tube, was found to have a spicule of glass in the anterior chamber pendent from the upper margin of the pupil. While the patient was in my office the foreign body fell behind the iris. There was sharp inflammatory reaction, and as a result of this the bit of glass doubtless became encysted. From then until the present time the patient has noticed no difference between the two eyes. It would seem that a foreign body incapable of undergoing chemical change and aseptic, as this one doubtless was, may remain in the eye for an indefinite time without producing harmful results.

DR. GEORGE S. DERBY, Boston: Whether one agrees or not with the Moorefields' teaching as to the advisability of extracting foreign bodies anteriorly, except those of large size, one must certainly admire tremendously their splendid technique, as developed in the British medical service, especially as I saw it in 83 General Hospital at Boulogne, in extracting foreign bodies. The foreign body was pulled into the anterior chamber, and an incision was made through the clear cornea with a straight keratome, very carefully, so that little aqueous was lost. A small magnet, manu-

factured by Weiss, of London, which works on dry cells, was placed over the foreign body, which was thus drawn up to the wound and emerged from it, without the necessity of introducing the instrument into the anterior chamber. Their technique was certainly beautiful and well worth seeing.

DR. C. F. CLARK, Columbus, Ohio: I should like to obtain the opinion of some of these gentlemen who, in the government service have had large experience, as to the risk of leaving a foreign body in the eye. There seems to be a conviction on the part of some observers that the war experience should materially modify the theories which have prevailed in the profession on this subject. We have been taught—and have for years acted on the belief—that a foreign body in the eye may and often will excite sympathetic ophthalmia even after forty, fifty, or even sixty years have elapsed since the original injury.

Is it not too soon to draw any conclusions regarding sympathetic ophthalmia from experience in this war? Has sufficient time elapsed?

DR. NELSON M. BLACK, Milwaukee: In regard to the question of the occurrence of sympathetic ophthalmia from retained foreign bodies, I was wondering whether a possible factor in not having more sympathetic disease could be due to the many and varied serums the men received—typhoid, paratyphoid on entering the service, and the antitetanic injections at the time of injury. Is that a factor worth considering?

DR. WILLIAM TARUN, Baltimore: I should like to speak of several phases of this subject. One is the advisability of enucleating an eye during panophthalmitis. Dr. Chisholm, of Baltimore, reported a series of 3000 eyes removed for various lesions. A great many were panophthalmitis, and he has not seen a single case of meningitis develop after removal of an eye for that cause.

Another phase is the development of sympathetic ophthalmia. Dr. Randolph asked me to see a young man, an employee of the Baltimore and Ohio Railroad, who had had an injury some years before. Dr. Randolph, at that time, had removed a piece of steel from the eye, and the preserva-

tion of the eyeball was perfect. The macular region was destroyed, and he had only eccentric fixation with the eye. Two months ago he returned with a history of being struck in the opposite eye. The *x*-ray showed a small foreign body in the vitreous, more or less movable as the eyeball was moved, and a short distance posterior to the lens. A number of hemorrhages were seen in the vitreous and on the retina below. Vision was then 20/60, and the question was whether to leave the eye alone or remove the foreign body. In view of the fact that he had had an injury to the opposite side, and that removal of this body would mean further destruction to the eye, I suggested that the eyeball be left alone, and that the patient be put on atropin, ice-compresses, rest glasses, and constitutional treatment with salicylate of soda and purgatives twice a week. I also suggested that he have his sinuses *x*-rayed, the teeth looked after, and the tonsils examined. All this was done, and there did not seem to be anything wrong. His vision later was 20/15 and is still so. The foreign body is still present. The irritation has subsided, and everything is perfectly quiescent. It is quite a responsibility to determine exactly what shall be done with this man. He has a bad eye on one side, and operative interference on the other side is needed. We are just keeping him under observation. The foreign body in this case was a piece of steel.

I am a believer in Elschnig's work. He has thrown much light on sympathetic ophthalmia. I do not think that it goes to one eye from the other, but believe that it is due to some constitutional cause or causes; and if those causes, such as pus conditions about the body, are eliminated, and the injury is of such a character that the pigment substance has not been destroyed from the entrance of the foreign body, I think that it is safe to allow the foreign body to remain without the prospect of causing serious damage to the individual in after life.

DR. ALLEN GREENWOOD, Boston: I want to suggest that we shall never come to an agreement, probably, as to the posterior and anterior route. That has to be decided by each operator, and the decision depends upon the conditions present and upon where the work is being done. In con-

sidering Dr. Shoemaker's paper, we must remember that his work was not connected with the military service in the very front line hospitals. In such circumstances, the anterior route for tiny foreign bodies probably offers the better operation, because it is difficult to get *x*-ray localization. If you have made the diagnosis with the magnet, the foreign body may be drawn into the anterior chamber without material damage if the operation is done by those accustomed to it. If, however, you have a small body in the eye at a hospital where a careful *x*-ray localization can be performed, then my preference is to draw the foreign body through a small opening in the sclera nearest the point where the foreign body lies. You must judge which route is best according to circumstances. The size of the foreign body and the personal equation must be taken into consideration, and also the man using the magnet and the magnet with which he is most familiar.

As far as sympathetic ophthalmia is concerned, the war is so recently finished that one cannot give an opinion. I saw only one case, during my entire service as consultant, in the various hospitals. In that case there was a non-magnetic foreign body in the eye, with a history of iridocyclitis of three weeks' duration. The offending eye was removed, and the sympathetic uveitis disappeared. I think that cases of sympathetic ophthalmia are going to be much less frequent than one would expect, considering the multitudes of ocular injuries. The affection has lost a little of its dread to the man who has seen much service, as the condition of the good eye depends on whether there is an iridocyclitis that persists, in addition to an inclusion of the foreign body.

DR. T. B. HOLLOWAY, Philadelphia: I wish to call attention to a complication in these cases that, while extra-ocular, may have wide-reaching effects. The surgeon at the Naval Hospital in Philadelphia referred a patient who had injured his eye while chipping steel. I found that a piece of metal had plowed its way directly through the lens and had lodged in the vitreous. I had no difficulty in drawing this large mass into the anterior chamber, but had difficulty in getting it through the corneal wound. I requested, from the interne who was assisting me, a spatula to depress the lips of the

wound. Another interne picked up the porcelain-lined instrument tray and brought it close enough to the heel of the magnet to draw the tray out of his hands. After the atmosphere cleared sufficiently I found that the mass of steel had been extracted and was attached to the tip of the magnet. I mention this because a nurse or some one else may inadvertently pick up one of these trays and bring it too close to the magnet, and the result may prove disastrous to the eye. In this case the eye was so badly damaged that it made but little difference. Enucleation would have been necessary under any circumstances.

CONCERNING THE OCULAR PHENOMENA IN THE PSYCHONEUROSES OF WARFARE.

G. E. DE SCHWEINITZ, M.D.,

Philadelphia.

The opportunities for the observations on which this communication is based were afforded in France and England in the winter of 1917–18, and in this country in United States Army General Hospital No. 30, Plattsburg Barracks, in December, 1918.

It is not necessary to discuss in detail the confusion which has occurred by reason of the unfortunate application of the term "shell-shock." Because in the earlier years of the war many men who had been exposed to shell-fire, or had been in the near vicinity of exploding shells, developed in unusual degree a variety of nervous phenomena, these were attributed to the concussions resulting from the explosions, and the term "shell-shock" came into existence. Later, all manner of nervous manifestations not specifically associated with what are ordinarily known as "peace-time neuroses" were classified under the same designation.

It is now well established by the studies of many expert

observers that the majority of these cases are examples, to use an oft-recorded definition, of "peace-time neuroses with a war-time coloring,"[1] and the "neurosis is a maladjustment of the individual to his environment; his way of meeting a difficult situation." It must always be remembered, as F. W. Parsons points out, that the results of a true neurosis, be it one of war time or one of peace time, are not conscious or voluntary.

Such cases have been classified by various systematic writers. Pearce Bailey[2] makes the following divisions:

1. *Concussions*, the affected individual having acquired minute, disseminated lesions of the central nervous system. Some recover quickly; some do not recover, at least, not satisfactorily, and some pass over into a neurotic state—an implantation of a neurosis on an organic base. The percentage of those who develop symptoms indicative of true brain concussion is comparatively small.

2. *Neuroses of Neurasthenic or Psychasthenic Type.*—These, as before noted, do not differ materially from the neuroses of civilian life. Some have symptoms suggesting endocrine disturbances. A certain number of cases develop as the result of intense physical exhaustion and recover quickly after rest.

3. *Hysterias.*—These, if Babinski's conception of hysteria is accepted, represent conditions produced by suggestion and curable by psychotherapy.

Captain L. C. Frost[3] has proposed a more condensed classification, or grouping, to wit:

Group A.—Shell concussion, to include such cases as present obvious physical lesions, or at least, such symptoms as may be assumed to interpret physical lesions. These comprise those individuals who have experienced concussions from exploding shells, the effects of atmospheric and gaseous compression, poisoning by carbon monoxid, etc.

Group B.—Shell hysteria, psychoneurosis, and war shock.

including those cases grouped in paragraphs 2 and 3 of the previously quoted classification. They should include those who, suffering temporarily from physical effects, recover from them, but acquire nervousness, or, as Captain Frost puts it, the transitory physical symptoms furnish not the cause but the starting point of the nervous phenomena—the affected individual becomes abnormally centered in the somatic symptoms.

Disregarding the comparatively small group of "concussioned" cases with organic lesions, except in incidental mention, I shall attempt to describe some of the ocular phenomena which pertain to those who comprise the functional group, *i. e.*, those with psychoneurosis, war shock, and hysteria. It is admittedly difficult to make sharp distinctions; they readily become artificial. So also a definite classification of the ocular symptoms is not a satisfactory one. However, for convenience' sake, the conditions may be grouped as: (1) Various types of amblyopia and amaurosis, including disturbances of color vision, types which in civilian practice have been included under the terms "incomplete and complete anesthesia of the visual sense." (2) Asthenopias and anomalies of accommodation. (3) Anomalies of the iris movements (pupil phenomena). (4) Anomalies of the eyelid and exterior eye-muscle movements. (5) Phenomena not included in the preceding groups.

1. *Amblyopia, Amaurosis, Achromatopsia, and Dyschromatopsia.*—To this group belong reduction of visual acuteness, or its complete loss, disturbance of the color sense, and anomalies of the visual field.

(*a*) *Amblyopia and Amaurosis.*—Ordinary reduction of visual power in hysteric patients is of no special importance, but the knowledge of a refractive error as it may have been reported, for example, by the examining officer at the time of the man's induction into the service, may readily furnish the suggestion which determines the symptoms of reduced acute-

ness of sight, for example, below the standard required in the army. Also the symptoms may be removed through the same channel.

Thus, a simple-minded recruit from the mountain regions of the southwest had been told by some traveling "eye doctor" during the period of his few months of "schooling" that his eyes were "weak" and "needed glasses." Bewildered by the strange surroundings of a training camp, backward in the acquisition of his duties, unmercifully "ragged" by his comrades, knowing that replacements for overseas work were being rapidly formed, dreading his inferiority because of supposed "weak eyes," alarmed by cruel stories of the horrors of foreign warfare, he developed a typical neurosis, the prominent symptoms being tremor, whispering voice, and amblyopia, the visual acuteness being reduced to less than 1/10 of normal. At first all attempts to improve the vision, although the eyes were perfectly healthy, were fruitless. The suggestion gently but insistently made that spectacles would restore the lost quota of sight and put him on an equality with those who possessed normal vision, with whom he would surely have to go, stimulated the instinct of self-preservation and vision became absolutely normal through glasses of negative refractive power. In the first instance he released himself from an intolerable situation by the development of a defect suggested by the eyes and in the second place relieved himself from an anticipated situation more intolerable than the first one by putting himself on equality with his comrades in the game of self-preservation, the restoration of vision suggesting the method of release.

Sometimes in place of a reduction of sight as tested with type-cards, the patient persists that the vision is "smoky," or "foggy" "nothing has ever been clear since I was shell-shocked." This may be a temporary condition, but in some soldiers remained for a long time, that is, long after all other signs of "nervousness" had apparently passed away.

It is possible that in some instances there really is an ocular cause for the blurred or cloudy vision. Thus, Terrien[4]

describes clouding of vision, which gradually ameliorates until there persist a diminution of visual acuteness and marked difficulty in fixing objects. He noted under these conditions retinal and papillary hyperemia, and suggests the possibility of retinal commotion as the cause of the foggy sight.

Referring now to complete, or practically complete, blindness among war neurotics, Kron's classification of bilateral hysteric amaurosis, as noted in civilian practice, made years ago,[5] may with propriety be retained with a few slight modifications: (*a*) Transitory forms lasting a few minutes; Auer has described transitory blindness lasting fifteen to twenty minutes, after a reprimand, fright under fire, or exposure to cold;[6] (*b*) short-enduring forms lasting for several hours to two weeks;[7] (*c*) long-enduring forms, lasting for months or even years.[8]

In general terms, the evolution of hysteric blindness, which may be more or less complete after a soldier is "shell-shocked" is as follows: During the period of being semi-conscious, or dazed, he is partly or entirely blind; vision often returns with the restoration of consciousness, or blindness may persist for varying periods of time, as already described, if the soldier's attention is fixed upon, or directed to, his eyes. Thus, as previously pointed out, and as noted by A. F. Hurst,[9] an error of refraction by a process of auto-suggestion may perpetuate the loss of vision.

Associated with this psychic or hysteric cecity, there may be tonic blepharospasm, that is, a convulsive closure of the lids, or clonic blepharospasm, that is, continued blinking of the lids, sometimes designated "fluttering" or "twinkling" of the lids. If an effort is made to raise the lid a definite resistance is demonstrable; if the patient under command tries to open the eye, the only response is a trembling movement with no or only slight separation of the ciliary margins. On forcing open the lids the eyes are usually rotated upward

and cannot be turned downward. The pupils react normally. The eye-grounds show no changes.

The symptoms of these neurotics and, therefore, also the amblyopias, do not, to use Frost's words, "arise haphazard, and they are always the definite effect of a definite suggestion in some form." He quotes Colonel Salmon in this regard: "The symptoms exhibited usually bear a more direct relation to the existing psychological situation than they could possibly bear to the localization of a neurologic injury. Thus, a soldier who bayonets an enemy in the face may develop an hysterical tic of his own facial muscles; hysterical blindness may follow particularly horrible sights, etc." A case recorded by F. W. Mott[10] illustrates this point. A shell burst near a man while he was attending to a wounded comrade. He dragged the wounded man into a culvert, but then found he was unable to see and had to be helped out. The emotional shock and the darkness of the culvert were responsible for the loss of visual function.

The restoration of vision may be prompt or deliberate, as already stated. According to J. Herbert Parsons, the eye to recover last is often the "shooting eye." In some cases there is a prolonged period of dull or smoky vision, or when the acute blindness subsides defective vision may remain, dependent upon spasm of the ciliary muscle, the apparent myopia thus produced being correctable with concave glasses.

Hysteric amblyopia or amaurosis of the character now under consideration may be bilateral or unilateral. Eder[11] states that unilateral amblyopia is probably more common than double amblyopia. This has not been my own experience. In those cases personally investigated in all instances both eyes were affected, but not always to the same degree. It has been stated by Cruchet[12] that the first color seen by the patient on recovery from hysteric blindness is red. His observations were made in civilian practice. Whether a similar observation has been made among those suffering

from war neuroses I do not know; personally I have no records in this regard.

Hurst maintains that the affected soldier does not move about like a blind man, but avoids hurting himself, though he does not relax the groping action of people with extremely defective sight. This observation was frequently made and commented upon by the earlier students of the visual phenomena of hysteria. In a word, the orientation of the affected individual is usually perfect. Various writers have in days gone by attempted a variety of explanations of this fact. Thus, it has been suggested that the peripheral visual impressions, although unperceived, bring about in the muscular apparatus, to use the language of Parinaud, those instinctive and unconscious movements by means of which we find our way through the external world. Groenouw states that hysteric patients with greatly contracted fields find no difficulty in getting about because the periphery of the retina still retains its power of perceiving large and bright objects. Wilbrand explains the phenomena by assuming that the irritability of the retinal periphery is not lost, and that the insufficiency of the retina is not so great when the patient is moving about as it is during steady fixation.

Such lack of inconvenience from contracted vision is, however, not always evident, as, for example, in the following case, quoted also as representative of the enduring forms of hysteric blindness.

A colored soldier, aged twenty, with a service of one year, part of which (from April, 1918, to November, 1918) was in France, while engaged in laying rails, began to complain of painful and inflamed eyes, which steadily grew worse as he was sent from one camp hospital to another, until finally he was returned to this country. There is no history of "shell-shock" in the ordinary sense of that term, but what may have been a slight conjunctivitis furnished the suggestion of

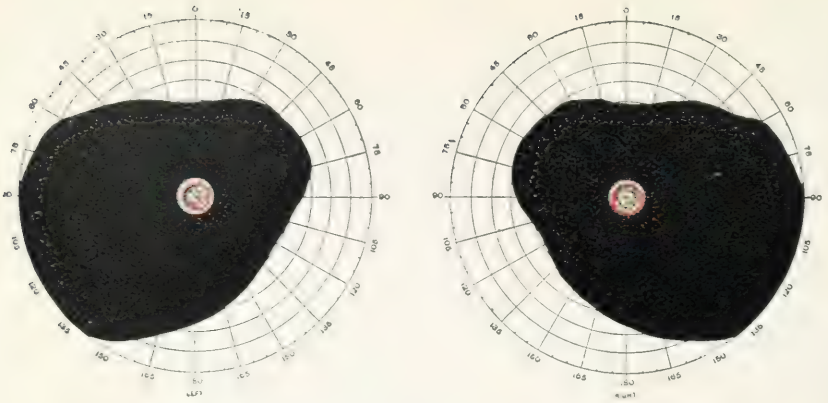

FIG. 1.

FIGS. 1 to 4. Hysterical amblyopia lasting eight months (see text). FIG. 1, typical tubular field. FIGS. 2–4 show gradual increase in size of field, easily brought about by suggestion.

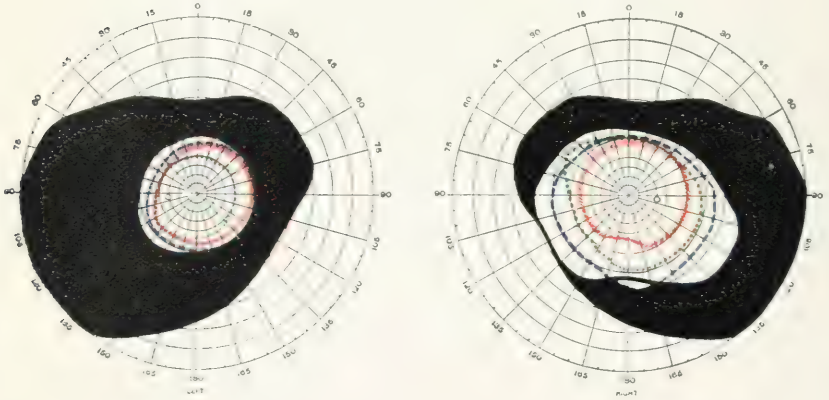

FIG. 2.

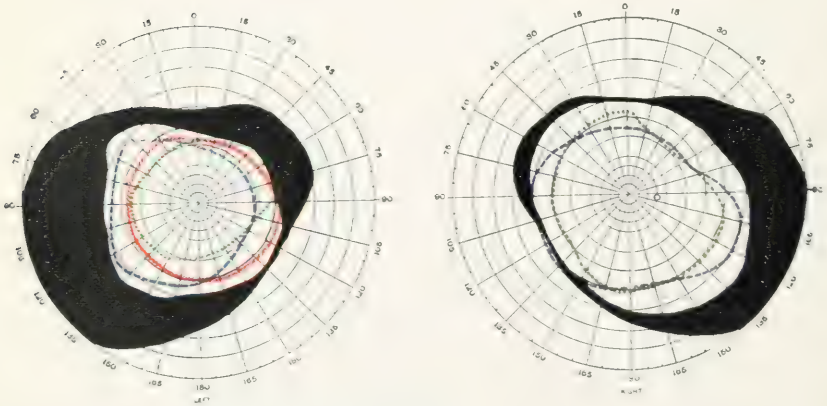

FIG. 3.

an escape from an intolerable situation. The records state that his vision was respectively 6/200 and 4/200, but when I examined him in December, 1918, it was not nearly equivalent to that, being at best object perception, and that uncertainly. Except for a moderate clonic blepharospasm and the blindness, his eyes and eye movements were normal in all respects. The records state "he stumbled over objects placed before him." He exhibited an almost constant general tremor, was excessively nervous, "jumpy," to use a colloquial term. Called from the hall into the examining room, he came with the hesitating step of a blind person but failed to avoid objects in the room, and once walked into a small metal chair, which, striking the floor, made a crashing noise that sent him into a fit of trembling so violent that it simulated a general convulsive seizure. He was not a malingerer (he was closely watched for a long time), and suffered real mental distress. After one month of treatment by suggestion, aided with electricity, he made a complete recovery in all respects. The first visual field obtainable was extremely concentrically contracted, and day by day widened until it assumed a fully normal extent. His period of blindness, therefore, lasted approximately eight months. (Figs. 1–4.)

It is necessary to be thorough in the examination of the cause of the blindness, or of the defective vision, in some of these cases, for occasionally, although the general symptoms of neurosis are present, and the history of shell or other type of war shock is complete, the eye phenomena in so far as they pertain to sight are really due to ocular lesions. I have referred to the possible relation of commotio retinæ to this condition.

Laignel-Levastine and Courbon[15] describe the case of a soldier previously syphilitic who had been "shocked" sixteen months prior to examination, which was followed by stereotyped "blinking" of the lids, and who was practically blind — a blindness not due to malingering and not susceptible to improvement under the influence of suggestion—who had

also external strabismus of the left eye and limitation of the exterior ocular movement in attempted rotations to the right, upward and in convergence. The pupils were small, but normal in reaction, and the papillæ showed only a slight departure from normal appearance. These changes and paresis of the ocular movements were attributed to meningitis; the blindness was not considered as an hysteric manifestation, although other symptoms of hysteria were clearly in evidence. Babinski, discussing this case, referred to observations of his own after cranial trauma, but also after "shell shock," where a diminished visual acuteness was noted (4 10—2 10 or lower), the papillæ being slightly hyperemic and mellowed. The disturbance of visual function he considered to be out of proportion to the ophthalmoscopic findings (in some instances these were normal), and suggests that nerve-head changes are due to an organic disturbance of unknown origin.

As an example of the difficulty in deciding whether sudden loss of vision should be ascribed to hysteria, or rather to a psychoneurosis, or to an organic change, the following case may be recorded.

While crossing on a transport, a boy, aged nineteen, of good repute and on duty in "the eyes of the ship," on a raw, windy, and cold day went suddenly practically completely blind, and was examined a few hours later in the sick bay of the ship. Pupil reactions, ocular movements and eye-grounds were normal. Vision was reduced to the perception of a moving object held very close to his eyes, and only in a small space of each visual field down and in. For a day or two he had much headache. All tests for the detection of malingering were negative, and all efforts in this respect by careful watching day or night were without result. He had no tremor, was not apprehensive, at least did not manifest apprehension, although he must have heard the daily "abandon ship" bugle and the noise of the gun practice, and knew the vessel was in the danger zone. He was dis-

tinctly lacking in mental alertness, and would sit for hours at a time almost absolutely motionless. He stated that once before, following a blow on the head, he had been temporarily blind for some weeks. Examined by Lieutenant-Colonel Mosher, no otolaryngologic or sinus lesions could be found; the general examination was negative. Facilities for a Wassermann test were not at hand.

The condition remained absolutely unchanged until about four or five days had expired, when a faint veiling of the nasal and upper edge of the optic disks was visible, an appearance not previously noted. On reaching Brest the patient was transferred to a French hospital, where every facility for examination was available. Through the courtesy of one of the naval officers, at the expiration of a month or six weeks a report was sent, which briefly summarized was this: In spite of a negative Wassermann, specific infection was suspected. Although he had had on board of ship a vigorous course of mercury by inunctions, the mercury was now administered hypodermically. Slowly, sight began to return; at the time of the report he could read large letters with one eye, and had a vision of about 10/70 in the other eye. Since that time no record of the final result has been obtainable.

This case is mentioned because it would appear that what must have been a retrobulbar neuritis, at least in all probability, presented in many respects the signs of a long-enduring type of functional blindness.

Not long ago opportunity was afforded for the examination of a soldier who had seen overseas service, and who was sent to the hospital for the purpose of determining whether grossly defective vision of the right eye was dependent on a lesion, or was the result of a neurosis, and evidently the opinion had been formed that the neurotic element was predominant. In point of fact, however, careful focussing revealed a diminutive lesion in the macula, almost certainly a very small rupture of the choroid, and yet fairly expert examination prior to his advent in the army hospital on this side had failed to discover this lesion.

Lagrange[11] makes reference to soldiers with loss of central vision without visible lesions in the macula in association, for example, with bruises of the face, and insists that they must not be considered as malingerers, explaining the central scotoma by the existence of disorders which are not revealed to the ophthalmoscope. In like manner, it may be stated that some of the cases of greatly defective vision in patients who have been classified as "shell-shock" really had a physical basis for the loss of sight, and it behooves the examiner to be painfully conscientious in his examination before disregarding the possibility of organic ocular lesion, even in the presence of the general symptoms of a neurosis. There is, of course, no reason why the two should not be combined.

(*b*) *The Visual Field Phenomena.*—Following the teachings of the Charcot School, it was for a long time definitely believed and stated that the essential characteristic of the visual field in hysteria is *concentric contraction*, which is evident at the beginning of the examination and is not produced by repeated measurement, and that the amount of reduction varies from a slight contraction to such extreme restriction that the most peripheral circle is just beyond the fixing point.

Sometimes the field was noted to have a *tubular character*—that is, the contracted visual field maintains the same size, no matter at what distance from the examined eye the point of fixation is placed (Fig. 1).

A constantly recorded variation consisted in the fact that the red field was the last to be affected, with the result that its extent exceeds that of blue, and becomes the most peripheral of the color circles. Occasionally charts of visual fields were produced where red was noted to be the most peripheral color of the entire field. This is the so-called *inversion of the color field* (Figs. 5 and 6).

As is well known, these visual field phenomena in hysteria are, according to Babinski, due to suggestion. If suggestion

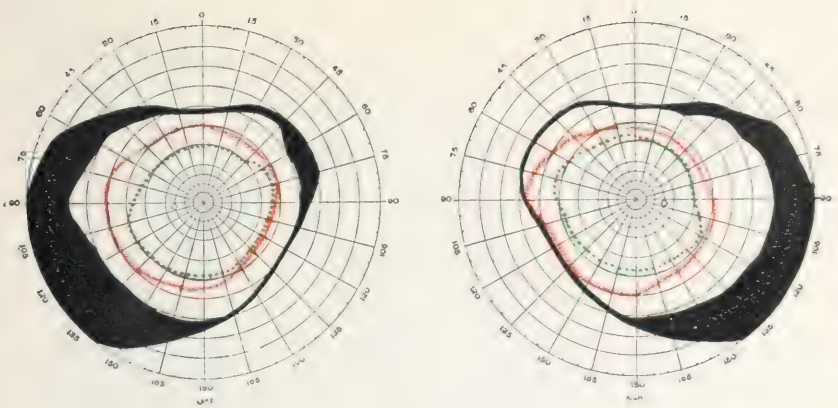

FIG. 4.

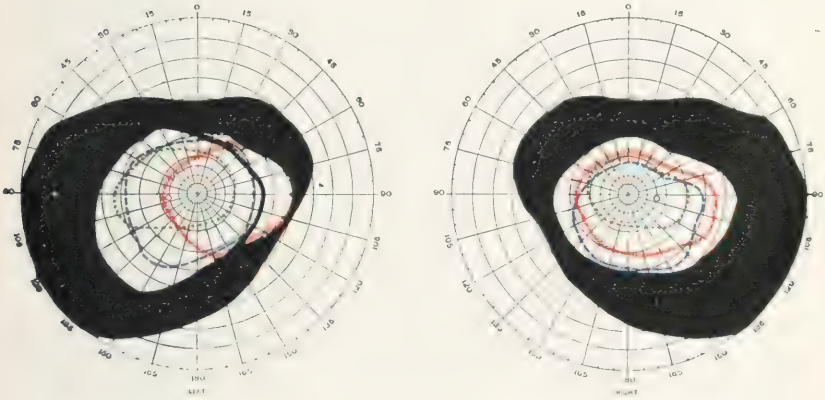

FIG. 5.

War shock and hysteria. Familiar contraction of field and partial inversion of color lines. Patient highly suggestible, V. $\frac{20}{L}$

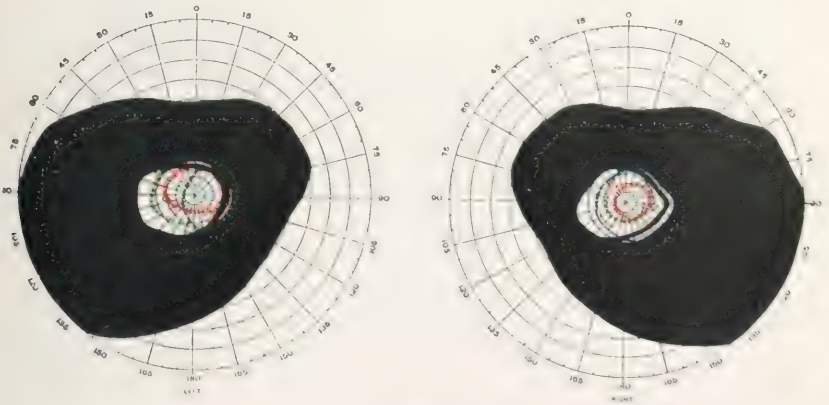

FIG. 6.

War shock and hysteria. Concentric contraction and color inversion. Note that red occupies in right field the smaller area.
Patient highly suggestible.

can be eliminated, he maintains they do not develop, and Morax, at first impressed as most observers were, with the significance of the retracted field of vision in hysteria, later adopted Babinski's views, and found that if suggestion was eliminated in the examination, this so-called hysteric contraction was not produced. Believing that it is impossible to avoid suggestion during ordinary perimetric examinations, he relies upon simpler methods, taking the field with the aid of outstretched fingers or other familiar objects.

Hurst and Symns[15] state that they have never seen patients with hysteric symptoms, apart from hysteric amblyopia, who spontaneously complained of disabilities resulting from a narrowed field of vision. When, however, the perimeter was used, the patient not infrequently described inconvenience on account of the limitation of his peripheral vision. Examination of numerous soldiers with various forms of war neuroses, all of whom were abnormally suggestible, never determined the presence of contraction of their visual fields until they were tested with the perimeter, which invariably resulted in the suggestion of a narrowed field, however carefully it was used. In the light of our present-day knowledge, there is no question that too great stress has been laid on concentric contraction of the visual field and inversion of the color lines as a stigma of hysteria, and I overemphasized these phenomena in my article on the Neuroses and Psychoses[16] written fourteen years ago, and endeavored to make distinctions between hysterias and neurasthenias based upon visual field examinations which were not justified, because I did not sufficiently realize, as many physicians at that time did not realize, the potent influence of suggestion. None the less these examinations are interesting and valuable in the study of such cases from the very fact that they demonstrate, or help to demonstrate, the presence of an abnormal nervous mechanism, which permits the ready acceptance of suggestion.

Hurst and Symns have made some very interesting observations on spiral fields among war neurotics. It will be remembered that von Reuss[17] described what he denominated the *fatigue spiral field*, which was thus produced. The first field having been already taken, the point at which the test-object in the second trial appears in the visual field on the horizontal meridian, for example, lies nearer to the center, and this is also the case in all meridians. When the examiner begins for the third time, the point of appearance of the test-object lies still nearer to the point of fixation, and so forth, until further contraction can no longer result and the later points of appearance of the test-objects coincide with the earlier ones. If all of these points are connected, a spiral line is formed which ultimately terminates in a closed line. Similar fields have also been described by Straub and Fuchs. Von Reuss was quite convinced that spirals were not more frequently observed because the search for them had not been an accurate one.

Writing on this subject, Hurst and Symns say: "If the examination was continued after the first field was marked out, a spiral field was always obtained, identical with that which has hitherto been regarded as a stigma of hysteria.[18] We believe that the reason why a spiral field of vision, which is the natural result of continued suggestion, has not been found in a larger proportion of hysteric cases, showing a narrowed field of vision, is simply because it has not been looked for, the examiner being content when he has marked the limit of vision a second time in each direction. It has generally been taught that a spiral field of vision is a result of fatigue, and it has even been stated that it is more frequently a symptom of neurasthenia than of hysteria. We have found that this is not the case, the inward spiral, which has hitherto alone been described, being a result of the method employed in using the perimeter. We have found that an outward spiral is always obtained instead of an

inward one if the white disc of the perimeter is moved outwards instead of inwards, as is commonly done. We have in this way even produced an inward spiral for one eye and an outward one for the other, or an inward spiral one day and an outward spiral another day, with the same eye" (Fig. 7).

It would seem that the so-called tubular field as ordinarily described has been but little if at all mentioned in the description of the visual field symptomatology of war neurotics. That it is often present and may readily be developed there is no manner of doubt, and I have numerous observations in this regard. It has sometimes been stated that a

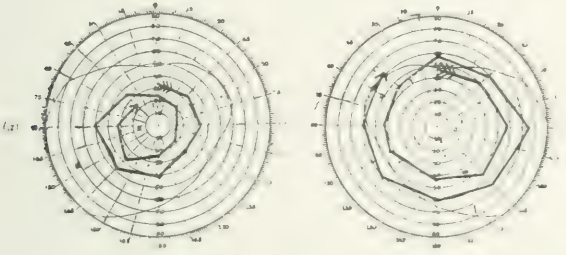

Fig. 7.

tubular field is more nearly a characteristic visual phenomenon among hysterics than other departures from the normal field of vision, and yet when one thinks about it, it becomes apparent that it is more easily suggested than any of the other types of field which have been mentioned, and as shall presently be shown on some of the charts, a very much contracted tubular field may be the first development of what may be called the return of vision after hysteric blindness (Figs. 1–4).

In summary, then, it may be stated that almost always among those who suffer from what has been called "shell-hysteria," or, in other words, the hysteria which resulted

from various forms of war shock, concentric contraction of the visual field, with and without inversion of the color lines, tubular fields, and spiral fields, as described by Hurst, are commonly observed and readily suggested. In addition to these were other variations, particularly in the position of the color lines, although the fields themselves were not greatly contracted, and those types of fields, particularly in some of the psychasthenic cases which in civilian life have so often been developed during the examinations of those who in general terms are classified among the neurasthenics—fields that are often called the "retinal tire fields." It has not seemed wise or useful to attempt to distinguish between the field phenomena of those who appear to be purely hysteric and those who have developed a neurosis of the neurasthenic or psychasthenic type.

(*c*) *Color Blindness.*—In addition to the chromatic aberrations in the visual field, classified under the general term of inversion of the color lines, a few cases of complete temporary loss of the color-sense have been recorded, therefore achromatopsias, and these without any material loss of form-sense, and associated with practically normal visual acuteness, as tested with type cards. An interesting case of this character is the following:

A boy, aged eighteen, well educated, had the position of flag-boy on a transport, the duties of which he well and accurately performed. Suddenly one morning, when the ship was about entering the submarine zone, and the natural activities of ship life were exceedingly acute, he announced to the supervising officer that he was no longer able to distinguish the colors. It had been noted that he was apprehensive and restless for some little time before this announcement was made. He was immediately sent to the sick bay and examined. Functional testing of his eyes produced normal results in every respect, except that he was totally color blind. He was kept in the ward for a few days, and little by little apparently helped by reassuring statements

which were made to him, not only in regard to the return of color perception, but to the safety of his position, his ability to recognize the colors returned and was ultimately entirely reëstablished.

Hysteric achromatopsia, using the term originally announced by Galezowski, is characterized by the patient's inability to distinguish any color, although he perfectly recognizes the outlines and shapes of objects. It has been well said, by whom I do not remember, that everything appears like a sketch in India ink. It has, moreover, been declared that although this hysteric color blindness may be complete, each color can be matched by a certain gray. In other words, the patient recognizes the equivalent gray tones, even more quickly than a normal individual. Such tests could not be made with the sailor whose symptoms have just been briefly described, nor am I able to state with accuracy the perception of which color he first acknowledged, but I think it was red, and this, if it is accurate, would correspond with the observation of Cruchet previously quoted.

When this boy was first examined it not unnaturally occurred to the observers that the temporary loss of color perception represented what has loosely been called "retinal exhaustion," but in the light of later experiences its explanation seems more likely to reside with that condition which is denominated an "anxiety reaction." Frederick W. Parsons,[19] referring to such reactions, writes: "Officers doubt their ability and worthiness to lead and have the responsibility of men. This is a transference of the emotion of fear for themselves to the possibility that injury may come to others." He refers to these cases as likely to prove stubborn, and not yielding to treatment as the gross hysteric symptoms do. The boy I have described had preceding his sudden loss of color perception a period of great anxiety, which increased as the transport entered, or was about to enter, the danger

zone, and it seems not impossible that he overestimated his own responsibilities and feared that his duties improperly performed might bring the whole ship's company into great danger. The loss of color sensation, considering his occupation and his anxiety, was subconsciously adopted as the means to escape from the intolerable situation.

2. *Asthenopias and Anomalies of Accommodation.*—Naturally many instances of prolonged asthenopia and weakness of the amplitude of accommodation have been observed, sometimes lasting for long periods and associated with foggy vision, as before described, especially if the subject has the background of an error of refraction, although this may be corrected. Spasm of the ciliary muscle producing a moderately high myopia, 4 D. or more, has been referred to, and this, as Morax and other observers have pointed out, may be the end-stage of blindness, or rather, the patient recovering from the blindness, may pass into a stage of ciliary spasm, which can be corrected with a concave glass, or dissipated by the use of a mydriatic, and also is sometimes associated with extreme convergence of the globes. These phenomena differ in no sense from those frequently observed among hysterics and also among those who are classified as neurasthenics, as they are encountered in civilian practice.

3. *Anomalies of the Iris Movements (Pupil Phenomena).*—Although usually, even among those who are temporarily blind as the result of various types of war neuroses, the reactions of the pupil are normal, sluggish response to light stimulus has been frequently noted. Guillain and Barre,[20] discussing the anomalies of the reactions of the pupils which have resulted from the commotion caused by the explosion of large projectiles without external wound, investigated twenty-six cases of so-called shell-shock. In some they found mydriasis, the pupils failing to react either to light or to accommodation. In some the pupils were unequal, and either on one side or the other, or on both sides, were irre-

sponsive to light impulse. They also describe a true Argyll-Robertson pupil, and refer to the so-called paradoxic light reaction. While these pupillary abnormalities were often transitory, lasting from three to twenty days, the period of their existence was occasionally longer, but ultimately the anomalies disappeared. They further make reference to certain rare cases of very long duration. In one man fifteen months after the shock the pupils were still unequal and reacted only sluggishly to light. In another case one year after the shock, the reflexes were not well marked, and dilatation and marked hippus were noted.

It would seem from the description, especially as in six of their cases there was a xanthochromatic cerebrospinal fluid, that there must have been cerebral hemorrhage, and the authors suggest that some of the pupillary phenomena may have been due to the products of hemolysis or the presence of clots at the base of the brain. They also suggest retinal commotion as a possible cause, and even commotion of the ciliary nerves under the influence of the explosive shock. It will therefore be seen that these pupillary phenomena do not belong, except perhaps those in which there was a temporary sluggish reaction, to the symptoms of a neurosis, or, in other words, that they had a very definite physical basis for their development. Such, too, must have been the explanation of the pupillary immobility and abolition of accommodation and convergence which has been described by Bergyl, and which he himself ascribes to the result of a cerebral concussion.

4. *Anomalies of the Eyelid and Exterior Eye-Muscle Movements.*—As is well known, in the studies of hysteria in civilian life mention is usually made of a certain number of cases of so-called hysteric palsies of the ocular muscles, which Binswanger maintained indicated a defect of the associated lateral movements, or a motor insufficiency of certain muscular movements closely connected with psychic processes. It

would seem, if they occur at all, that there is an apparent paralysis of movement and not of the muscle supplied by a given nerve. In those cases of so-called shell-shock coming under my own observation I never noted any phenomena which would belong to this group.

Extreme convergence of the visual axes in association with spasm of accommodation has been mentioned. Descomps, Enzière, and Mère[21] describe a convergence of the eyeballs immediately after rotary tests have been made in individuals who have been shell-shocked; one eye may converge more than the other. The convergence lasts from eight to sixty seconds. They also speak of functional or organic palsies of the eyes. No explanation of these phenomena is given.

True nystagmus must have been exceedingly rare.[22] Very frequently nystagmoid movements could be developed in forced rotation of the eyes in the lateral directions. A curious speech defect was evident in many of the war neurotics, not exactly a stuttering, but a repetition of a single word, or brief sentence; for example, the soldier would say: "I was shocked, I was shocked, I was shocked, I was shocked, in the, in the, in the, in the, Argonne." Sometimes these repetitions were many in number, half a dozen or more, before the final word of the sentence was reached. Almost always there was an associated trembling of the lips and general tremor, and almost invariably, if these patients were made to turn their eyes sharply to the right or left, a jerking nystagmic movement was developed. In other words, it was a species of tremor.

Moreau[23] has written a paper on cases of nystagmus in concussion. In one case, for example, the soldier was shocked by the explosion of a large shell; coma followed; there was no external wound. Nystagmus resulted, the oscillations varying from 100 to 140 a minute. In another case, in addition to the nystagmus (the patient had been buried by the explosion of a shell, although there was no wound), he also

had marked clouding of vision. The nystagmus appeared immediately after the trauma and had not changed. No other ocular defects were found. Moreau does not attempt to give an explanation of the phenomena.

Of the eyelid peculiarities, blepharospasm, already referred to, was most common, sometimes clonic and sometimes tonic, and often in association with gross visual defects, as well as photophobia, this photophobia usually associated with a mild conjunctivitis, especially if at the time of the accident sand or smoke, or other irritating agent, had gotten into the eyes. The combination of photophobia, blepharospasm, with ciliary spasm, amblyopia and contracted fields, Coutela[24] denominates the "syndrome commotionel oculaire."

5. Exophthalmos has been noted among the war neurotics. In one case I observed the condition was marked, steadily increased for a few days, and the soldier's gait resembled that of cerebellar ataxia. Babonne and Celos[25] report two cases of mild exophthalmic goiter, which developed shortly after shell-shock. In one there was definite exophthalmos, in the other it was only slightly present, and nystagmic movements appeared in extreme rotations of the eyes.

Lortat-Jacob and Hallez[26] have recorded the case history of a young soldier who suffered from shell-shock without external injury. After an initial asthenopia, he developed about five weeks after the shock a pure paralysis of the left sympathetic—left miosis, narrowed palpebral fissure, enophthalmos, and false ptosis. The fields and eyegrounds were normal. *X*-ray of the cervicodorsal region was negative. Although organic cause for this condition was not discovered, it is difficult to believe it did not exist.

A word may be said in regard to the physical characteristics of the patients who suffered from so-called shell-shock, remembering that shell-shock is now used as equivalent to a neurosis, because many of the subjects never heard the sound

of a bursting shell, but none the less had all of the symptoms of those who had been exposed to concussion from this influence, although they were not themselves wounded. It is well known, to use the words of an eminent neurologist, that the neuropathy which we term hysteria is expressive of a biologic inferiority, and in many studies that have been made among the subjects of the war neuroses the majority of the patients have shown a neuropathic tendency or inheritance. Moreover, it was often possible to obtain a neurotic family history, including insanity, epilepsy, alcoholism, and general nervousness, and the neuropathic constitution of the patient himself was frequently demonstrated. All this side of the question has been elaborately discussed by many neurologists both here and abroad, and an excellent paper on this subject has been written in our own country by Dr. Francis X. Dercum.[27]

It is evident that these war neuroses do not differ from the peace neuroses in their symptoms and evolution except in the association of the war coloring. The paper has not been burdened with long case histories, but the charts of vision may be interesting, and represent studies that were made in the U. S. General Hospital No. 30, at Plattsburg Barracks, and for the charts and help in this regard I am indebted to Captain Julius Newgord, Chief of the Eye, Ear, Nose, and Throat Department of that hospital. Only a few of the numerous fields which have been charted are reproduced. Others are similar and represent various types of visual field disturbance which have been referred to in the paper.

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DISCUSSION.

DR. WILLIAM H. WILDER, Chicago: I realize the difficulty of discussing a subject like this that has been presented so well. However, it seems to me that with the class of men under consideration, who have been under such stress and strain, it must be extremely difficult to differentiate wilful from unwilful manifestations. Possibly it is much the same as it would be in civil life in the case of an individual alleging injury and seeking to recover for damages. From what we read it would seem that some of the manifestations are those of nerve fatigue brought about by continued shocks to the nervous system. The nervous system, in consequence, may be in an unstable condition, somewhat as it is in hysteria, so that the individual may have peculiar inversion of the color fields, and impairment of nerve function in other ways. Recently I have seen a case, such as Dr. de Schweinitz

mentions, of complete abolition of the color sense, apparently from shell shock. This young man, a soldier, came to me for examination from the Vocational Board of Chicago. He was prevented from returning to his former avocation, that of an engine man, because of complete color blindness. I do not know the previous history, but he stated that, when in the service of the Rock Island railroad, which requires very careful vision tests of its employees and perfect color sense, he was perfectly normal for red and green. When I tested him he was absolutely blind for red and green. There were no lesions of the eye discernible. The fundus was perfectly normal, and yet he must be excluded, and probably will be, from railroad service on account of his color defect. This is the only case that has come under my observation.

DR. ALLEN GREENWOOD, Boston: My apology for coming before you so often is that this is a Victory meeting, and the question of war conditions has come up, and one expression that Dr. de Schweinitz has used impels me to make the following statement: He has used the expression, "an intolerable situation," and one of the manifestations of the war neurosis, created by an intolerable situation, was the deplorable fact that some of the men who came to the evacuation hospitals had self-inflicted injuries. They were in such numbers that the cause of the wounds became quite apparent and it also became evident that the condition was more or less contagious, coming at certain times and among certain groups of men. I remember serving as triage officer of No. 7 Evacuation Hospital one night, and kept a record of the names of the men and where they came from. During that night I found twenty-five men who had either shot off the middle or forefinger of the left hand or shot a bullet between the big toe and the first toe or between the first and second toe. Those were the four principal locations. A few had shot themselves through the palm of the left hand. I doubt, from my observation, whether these men were really cowards. They came to "an intolerable situation," and found that men were being sent back with minor injuries; so they inflicted these minor injuries on themselves. Another night, when assisting the general surgeons, I did not see any such injuries.

DR. GEORGE E. DE SCHWEINITZ, Philadelphia: The cases to which Dr. Wilder refers belong to a group not mentioned in the résumé I have given, but which are discussed in the paper. They are the so-called exhaustion cases, and belong to the psychasthenias. The patients almost invariably recover under the influence of rest, and the symptoms usually disappear rapidly.

Occasionally, among war-shock patients, that is, those with hysteria, the blindness or defective vision has an organic basis, for example, an associated commotio retinæ; in one instance a diminutive macular lesion, probably a small choroidal rupture. A point of interest, also noted by Parsons, in cases of psychic blindness is that the "shooting eye" is the last one to recover.

TRACHOMA IN THE CAMPS AND HOSPITALS OF THE ARMY.*

A BRIEF SURVEY OF THE SUBJECT FROM A MILITARY POINT OF VIEW.

BURTON CHANCE, M.D.,
Philadelphia.

Thoughts of trachoma, and the fear that it might infect the country, have deeply occupied the minds of American ophthalmologists and sanitarians for the past fifty years, for as the disease is found well-nigh universally, the admission into this country of immigrants of the lower orders from eastern Europe, Asia Minor, and the Mediterranean prov-

* This communication is of necessity limited, more or less, to my personal observation and experience. Because of military exigencies it is not possible for me to give accounts from all departments of army endeavor and the regulations regarding trachoma in each camp and hospital. To the officials of the Surgeon General's office I am indebted for permission to present to the Society, at this time, any account whatsoever. To Dr. de Schweinitz especially am I grateful for opportunities to consult the official records in his care and for the privilege to publish what I here present. My report, therefore, can serve as a brief introduction to that extensive account which Dr. de Schweinitz shall later on make to the surgical history of the war.

inces, Arabia, Palestine, and Egypt, as well as from parts of Prussia and Russia, regions of the earth where the disease has been known to exist for centuries, has increased the menace excited by the infection imported by the early Irish immigrants at about 1850. Yet, from the investigations by the Public Health Service a number of years ago, it was learned that this country contains certain somewhat isolated areas where the disease exists, and it was found more or less constantly throughout Appalachian America, in some portions of which the infection was found to be as high as 12 per cent. of the population, while in others an even higher scale of infection was found.

Trachoma has been classed by the Government as a dangerous contagious disease, and, because of the widespread prevalence in the areas of the United States alluded to, the Public Health Service established in these sections six ophthalmic hospitals for the treatment of the disease. These hospitals have been maintained in operation for several years past, and, according to the report of July 13, 1917, during the previous year a total of 19,530 patients were treated. Entire families, including both extremes of life, were found suffering from trachoma. Accordingly, the officials of that service uttered a cry of warning as to the dangers incident to the enlisting into the army recruits affected with trachoma, and defined "that it is our duty to prevent the admission to the army recruits who may spread the disease."

The history of European wars shows that trachoma became a grave menace to the efficiency of the fighting forces by invaliding thousands of men, blinding large numbers at one time; indeed, so great has been the prevalence of trachoma in armies that it has been termed "military ophthalmia." Its introduction into armies has almost always come from the surrounding civil population, commonly from the areas from which recruits have been accepted, who

in turn give it back to the people, often with increased severity, when discharged after serving their enlistment or when they have become incapacitated.

It is said of the Belgian army that one soldier in every five, in the first half of the nineteenth century, suffered from trachoma, and it has been stated that in the past century and a quarter the English, Prussian, Russian, and other armies suffered from the ravages of the disease; while during the Russo-Japanese War trachoma was a formidable enemy to be reckoned with in the Japanese army. In the first half of the present war an epidemic of trachoma was reported to have broken out in France, having been brought into the country by the African soldiers and laborers; nevertheless, the disease in the army was checked by the quick isolation of all its victims. This report excited the fear that our soldiers might be dangerously exposed from contact with the Allies. The sequel, however, shows that from the care instituted by our Medical Corps and the concentration of the troops in a designated sector the disease failed to spread among the American forces.

At the time of the declaration of war by this country, in April, 1917, the presence of trachoma was cause for the rejection of a recruit. The Surgeon General's office was keenly alive to the possibilities of the case, and early sought to impress upon the military authorities the importance of preventing the admission into the army of any infected recruit. In the initial regulations for the Selective Service Act, May 18, 1917, the presence of this disease caused rejection, and, throughout the war, the Medical Department sought to protect the army and the public by insuring isolation of the infected, as well as provision for their treatment, at special hospitals. The Surgeon General recommended that a concentration camp, in all respects like a national army cantonment or a national guard camp, be established for the treatment of those infected, as well as providing for

the training of the soldier, with a staff attached to carry out the form of treatment pursued by the Public Health Service at the hospitals at Grayson Springs, Cerulean Springs, and Olympian Springs, in Kentucky. And, realizing that errors in diagnosis might occur whereby a draftee affected by a benign conjunctivitis would seek to avoid military duty by advancing the false plea of "trachoma," all affected by a suspicious conjunctivitis, would be retained and committed to hospitals for treatment and held until the course and treatment verified the diagnosis. It was suggested, in order to exclude none at all likely to be available for military duty, that, in the second draft, such infected ones might properly be classed in the "deferred remediable group," and could be accepted with safety pending treatment at the concentration camp. And, further, all afflicted, but otherwise qualified, whose visual acuteness was at the standard, or if below, capable of improvement, in the opinion of the ophthalmologist of the Advisory Board, if improved by treatment would be accepted. It was cause for great regret, to those deeply interested, that these suggestions did not receive the approval of the military authorities.

In the Medical Department's desire to spare no effort to cure the disease and to prevent its spread, the methods of the Public Health Service were studied and carried out in a small group of true cases which were operated upon by Surgeon McMullen and were later sent to duty.

In spite of all precautions it was found that boards had accepted draftees afflicted, and these were in the training camps to which draftees from infected districts were mobilized. And, further, the sick and wounded reports showed that many were discharged to civil life who, it was feared, might prove to be a dangerous menace to their several communities.

As is well known to all, the ophthalmologists assigned to posts throughout the army spared no exertion to segregate

all suspicious cases of conjunctivitis, and, as time went on, such cases as improved rapidly under treatment, or were of a doubtful diagnosis, were retained in the base hospitals, and every precaution was taken to avoid the possibility of contamination; while from military necessity those with far-advanced trachoma, presenting pannus, scar-tissue, induration, and granules on the bulbar conjunctiva, were recommended for discharge from the service. But by June, 1918, according to the Standards of Physical Examinations, P.M.G.O., No. 75, trachoma fell under the classification of those who "shall be unconditionally rejected from military service."

It may be of interest to know something of the experiences in the armies of the Allies and others, although full reports are not yet available.

Kirchner, of Berlin,* from his observations in the Prussian army up to 1917, declared that thus far trachoma had proved to be an entirely negligible quantity in military problems, yet Zimmer, of Avignon,† had found in ten months' service 27 per cent. of his ophthalmic cases to have been thus afflicted, and during his captivity in Germany he observed that 50 per cent. of the Russian prisoners had the disease.

Hanford McKee,‡ from the scarcity of cases found during his association with the Canadian forces, was led to believe that trachoma has almost entirely disappeared as a military disease.

Sir James Barrett,§ of the Royal Army Medical Corps in Egypt, made a rather startling contribution, for he records that in 1915 practically none of the soldiers contracted trachoma, and such as were afflicted came from Australia.

Eason,‖ of the Egyptian Expeditionary Forces, in dis-

* Abstr. Ann. d'Ocul., clv, p. 111.
† La Clin. Opht., December, 1916, xxi, 723.
‡ Trans. Ophth. Soc. U. K., 1918, xxxviii, p. 324.
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‖ Trans. Ophth. Soc. U. K., 1918, xxxviii, p. 30.

cussing military ophthalmia in Egypt, in the period 1915–1918, recorded 64 cases of old-standing disease and 39 recent trachoma, 26 of which were found in Australians. In one's ignorance one is startled to learn that trachoma is prevalent in that but recently discovered Continent. Of the 26, it was asserted that only two had possibly acquired the disease in Egypt. This circumstance throws a flood of light on the supposed contagiousness of trachoma among Europeans, and incidentally on the legislation adopted in the various countries with regard to persons suffering from trachoma, for it must be remembered that practically all Egyptians are diseased, and yet, despite the fact that the Egyptian Labor Corps worked for weeks and months alongside the Australian and British troops, and that large numbers of Egyptian orderlies served in the British hospitals, there was entire freedom from infection. Accordingly, trachoma has been practically non-existent as a disease among the British troops in Egypt and Palestine. These officers did not hesitate to declare that with modern habits of personal cleanliness and camp sanitation, trachoma is not actively infectious among large bodies of men, and accordingly there could be no danger of the army becoming infected in Egypt, and they believed that discharged soldiers infected would not spread the disease on their return to England.

As to ophthalmia in the Turkish army, from figures from one of the prisoners of war camps in Egypt it is evident that trachoma was prevalent among Turkish troops, for from July, 1917, to January, 1918, in an average monthly camp population of 8000, among 1163 cases of ophthalmia, 290 were of simple trachoma. Such a record might have been expected, since trachoma next to malaria has been known to be the most prevalent disease in Palestine.

From the establishment of the organized Medical Service in the camps and hospitals in America, to January 1, 1919, trachoma was reported from 36 posts, and the total

number of cases equaled 860. In only three camps did the number exceed 100 cases, to wit: Taylor, 125; Cody, 191; Greene, 122; while at Cape May there were 64, and at Pike, 69. With these greatest numbers, the numbers at the others ranged from 1 to 45, the total average being only 23. It can thus be seen that the disease was not a problem after all.

It is not at this date possible to obtain the statistics of the overseas cases. As we have already learned from Lieutenant Colonel Greenwood's interesting and graphic reports at the recent meeting of the American Medical Association, trachoma was sought for from the earliest days of the arrival of the forces. In the contagious stages, or when suspected, all cases were sent to special base centers where they were segregated and treated under precautions to prevent the spreading of the disease, and the infected and others were instructed in the care of towels and handkerchiefs. Severe cases requiring lengthy treatment, whose vision it was likely would be reduced, were as speedily as possible recommended for discharge and routed back to America. They were passed on and on from one hospital to another until, as was the course in my own cases, they reached New York or Newport News and finally Cape May.

My own army experience with the disease occurred in the service at Camp Jackson, Columbia, S. C., from September to December 22, 1917, and for the period from May to December 4, 1918, as Chief of the Ophthalmic Section of the General Hospital No. 11, at Cape May. To the cantonment at Camp Jackson were sent draftees from the Carolinas, eastern Tennessee, Arkansas, and Florida, comprising a goodly portion of the lower Appalachian region. I served on the board of experts in the examination of the draftees, and when the base hospital was established, in the wards as well as on the Board. The Committee of Ophthalmology of the Council of National Defense, coöperating with the Surgeon

General's office, had anticipated a horde of reeking cases, so that I, having striven all my professional days to escape trachoma, had visions of returning home blinded and a menace to my family. But either the Public Health Service had so thoroughly cured the eligible young men, or the ophthalmologists of the local draft boards had so skilfully diagnosed the diseased lids of the draftees, that, up to Christmas, 1917, I rejected only 35 undoubted cases of trachoma, and three other suspicious ones, of whom I felt safe in classing as "granular conjunctivitis." I turned the eyelids of every man presented to me irrespective of the complaints or the object of the examination. The follicular type was that most encountered, although several had granulations in the retrotarsal folds and a few showed cicatrices of the tarsal conjunctiva. I did not see a case of trachoma with pannus. Several of the cases had quite active symptoms. These were isolated and treated at first in an early established "Field Hospital," but later on, when the base hospital was opened, a ward was set aside to receive them. Here were pursued the commonly accepted "mechanical measures," to which I added the swabbing of the upper retrotarsal folds with the glycerol of tannin. At that period the subject of the disposition of the trachomatous was not yet settled. In recording the cases I made every effort to impress upon the rejected men the importance of the disease and directed them to report to their physicians and to their local boards.

At Cape May I received a small number of patients from posts in America, but the rest were returned overseas men. Many of them had enlisted and gone over with the first army, while several had gone over with the Canadians, and some had enlisted in British organizations. More than one man declared that his eyes first became acutely inflamed on the voyage to France. Up to January 1, 1919, 64 cases were reported as having trachoma. Of these I wish to speak of 26 undoubted cases, only 3 of which were unilateral.

Every man declared that the disease arose after entering the army, yet on closer questioning admitted having had ophthalmia in past years. Only 4 presented the follicular type solely. The others exhibited cicatrices in the tarsal tissues; 5 showed pannus and involvement of the corneal tissues; 3 showed granulation of the bulbar conjunctiva. One had large exuberant granules, the like of which I remembered having seen years ago, before the stringent rejection of immigrants became enforced. He was a horse ranchman; and was evidently suffering from a recrudescence of the disease, because he admitted having had previous attacks.

None had active ulceration of the cornea. One had dacryocystitis. One of those with pannus was a negro from Maryland. None of the patients in the wards, *e. g.*, those who had had an eye excised because of injuries, etc., exhibited signs of trachoma. I saw no signs of the disease in any commissioned officers under my care or observation.

I had the men isolated in rooms as far away as could be from healthy men until it was possible to obtain two cottages adjacent to the hospital. By this time Lieutenant William A. Krieger and Lieutenant Warren Reese were assigned to duty at the hospital. They alternated weekly tours of service. On Mondays I made a regular round of inspection of the quarters and examined each patient, directed the treatment, and recommended the disposition of the cases. All patients in the ophthalmologic section were given frequent douches of sulphate of zinc. The routine treatment of the trachomatous consisted of repeated daily cleansing of the conjunctival sacs with weak bichlorid of mercury solutions, and, in the active cases, mechanical measures were persistently carried out. Twice or thrice a week boroglycerid and tannoglycerid applications were made to the fullest extent of the membrane, with extremely satisfactory results in most cases. Expression by Knapp's roller-forceps was practised by Lieutenant Krieger with great benefit, one case

with abundant and prodigious granulation, from which the man had not been able to open his extraordinarily swollen lids for several weeks, yielded almost miraculously after thorough expression. Except in this case, none presented unusual symptoms -at least nothing more than I had had in my hospital service in Philadelphia. I did not regard any as worthy of excision of the retrotarsal folds.

The men were kept under surveillance until the discharges became mucoid and the follicles absorbed, with sufficient regression to justify "S. C. D."

DISCUSSION.

Dr. William H. Wilder, Chicago: My impression is that the number of cases of trachoma that we saw in Camp Taylor is considerably larger than that mentioned by Dr. Chance. I do not know how our records went in, but Major Barton, who later became head of the department of ophthalmology after I left the camp, told me that according to the early statistics of 1918, something like 275 cases had been sent from the camp because of trachoma. This number included some doubtful cases, but not a large percentage, because the review board early inaugurated the practice of sending back any draftee who had symptoms that we regarded as suspicious. We did not want to keep any such cases for treatment for a number of weeks, although there was a strong effort made by the Public Health Service to have a separate ward set aside for the treatment of these cases. This was deemed inadvisable by Colonel Allen, and I think wisely so. He discharged these men and asked the boards to return sound men. The reason that there was so much trachoma in Camp Taylor was that the men in that camp were drawn from Indiana, Kentucky, and the southern part of Illinois. Those who are familiar with the middle states know that there is a great prevalence of trachoma among the native born in the southern part of Illinois. The population there is made up of an immigration which came from eastern Kentucky and southern Indiana in the early days. In that region, between the Mississippi, the Ohio, and the Wabash rivers, is one that is

known as the Egypt of Illinois, and there is a great proportion of trachoma among the native population.

Some of the men from Kentucky, knowing that trachoma cases were being sent home, endeavored to deceive the medical officers by exciting inflammation of the eyes that they thought simulated trachoma. They developed puzzling forms of conjunctivitis that would yield to treatment and then recur in a few days. I put my sergeant on the track of one man and he found he was rubbing into his eye carbolic acid furnished by a druggist at home. Another man, a friend of the first, hesitated about using carbolic acid and rubbed soap into his eyes. Another produced an active conjunctivitis by rubbing dirt beneath his lids. These men were arrested and sentenced by a court martial to three years at hard labor.

DR. NELSON M. BLACK, Milwaukee: After the subcommittee on ophthalmology of the general Medical Board of the Council of National Defense came into existence, the question of trachoma in the army was considered, and certain recommendations were made to the Surgeon General. Later, when the Council of National Defense was connected with the Surgeon General's Office by the appointment of one of its members in that office, further attention was given to the question. In the latter part of 1917 a letter from Dr. McCormack, of Kentucky, to the Surgeon General, with an indorsement from Surgeon General Blue, suggested that trachoma could be cured by the method used in the United States Public Health Service. The reply to Dr. McCormack was that the average ophthalmologist did not think that trachoma could be cured in the time mentioned and make the individual safe for acceptance in the army. I was representing ophthalmology in the Surgeon-General's Office at this time and in January, 1918, was ordered to the trachoma infected districts of eastern Kentucky and Tennessee, to observe the treatment instituted by the representative of the United States Public Health Service, Dr. McMullen, with a view of making recommendations as to the disposition of cases of trachoma in the army; also to make recommendations to the Provost Marshal General's Office as to accepting infected individuals in the draft. The result of the observa-

tions made conclusively proved to my mind that the majority of cases of trachoma in young adults of draft age could, under the treatment instituted by the Public Health Service, be cured, and in a time sufficiently limited to permit of the man's being available for service. Recommendations were made that a trachoma concentration camp be formed, to which should be sent men from the various camps for observation, treatment, and training. The general staff, however, did not see fit to accept these recommendations, so the trachoma concentration camp never developed. Trachoma for a time was listed as one of the remediable diseases in the regulations governing the examination of the selective service. Later, this was disapproved, and all trachoma cases were to be rejected. Still later on, those in the service were received for treatment in the base hospitals and if not cured in a certain length of time were to be discharged.

As to the question of the transference of contagion in our armies, I think that the training the men received in personal hygiene, and the establishment of an ophthalmological section in the medical department of the army, made the possibility of infecting the army practically nil. The men took care of their eyes. If they had eye trouble, they went to the regimental surgeon, who sent them to the field hospital, and from there they were sent to the base hospitals where a well-organized ophthalmic service existed and proper precautions taken to prevent its spread.

Dr. Burton Chance, Philadelphia: It was not possible for me to see all the records which have been sent to the Surgeon General's office, therefore I limited my statement of statistics to those which were received up to the first of January, 1919. It is quite likely that there were other cases in Camp Taylor, but how many more there were I cannot tell.

OCULAR COMPLICATIONS DUE TO TYPHOID INOCULATIONS.

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General Hospital No. 6, Fort McPherson, Ga.*

It is with reluctance that I present a subject before this Society about which there is admittedly some doubt, but as it is not generally known that ocular lesions have been attributable to typhoid inoculations, it seems worth while at this time to record five cases of uveal infections which directly followed these inoculations, and to briefly review the literature of the subject, which is exceedingly scant.

Before proceeding with the histories it is interesting to note the opinion of Lieutenant-Colonel H. J. Nichols, of the Army Medical School, who replies to my query as follows: "No doubt slight effects could be found in certain cases, as the eye undoubtedly will share in some of the general reactions, but I cannot believe that these effects on the eye can be of much importance, as among the vast number of men who have been inoculated and followed up in the service we have no records of any specific damage to the eye as a result of typhoid inoculations, and, so far as I know, there is no specific lesion in the eye during a course of typhoid. I have occasionally seen in rabbits corneal opacity following an intravenous injection of typhoid vaccine, but this is a non-specific effect produced by a tremendous dose."

Case I.—Mr. B., aged thirty-five, lawyer, now a Captain of Infantry, was admitted to the First Officers' Training School at Ft. McPherson, Ga., May 11, 1917, after having

* Authorized to publish, Board of Publication, S. G. O.

passed the usual rigid examination. On May 12th he received the first inoculation against typhoid, a triple saline vaccine. The general reaction was greater than usual, and the following day the right eye became a little inflamed, and on May 14th he reported to the post hospital for treatment, where he was confined and treated for an acute conjunctivitis. As the eye grew worse I, then in civil practice, was asked to see him. The picture was a typical iritis. The case was very stubborn, and the pain was intense. There was no history or evidence of previous eye trouble; he denied lues, but acknowledged an old Neisser infection. A blood Wassermann was negative, but there was a slight positive reaction to a complement-fixation test for gonorrhea. Teeth and gums appeared negative, as was the nose and throat examination. No *x-ray* examination was made. He was well with normal vision on June 17th, and was dismissed from the school. He later entered the Second Officers' Training School and graduated. I do not know that he received other inoculations, but I assume that he did.

Case II.—Mr. L., aged twenty-two, entered the same training school May 11, 1917, after having passed the usual physical examinations. I was told that his vision was below standard, but could be brought to 20 20 with glasses. He received his first typhoid inoculation, triple saline vaccine, on May 14th; the second on May 20th, and the third on May 27th, with the usual general reaction. On June 1st he reported to my office complaining of blurred vision in the left eye of several days' duration. V. 20 30. There was a slight pericorneal injection, a few dots of keratitis punctata, vitreous opacities, and an area of acute choroiditis about the size of the disc situated below the macular region, and another smaller area between the superior vessels about a disc diameter from the nerve-head. There was no previous eye history, he denied lues and gonorrhea, but the blood Wassermann (civil) was positive++. No other source of infection could be found. In due time he was rejected and returned to his home for treatment.

Case III.—Negro soldier, Camp Gordon, came to the eye clinic, Emory University, some time in July, 1917. A few days previously he had received his second typhoid inocula-

tion (triple saline vaccine), and the left eye became inflamed the following day. Typical iritis. There was no evidence or history of previous eye trouble, and he denied venereal infections. A Wassermann was negative. He was referred to the base hospital of his camp for treatment.

CASE IV.—Mrs. K., aged forty, seen at the Emory University eye clinic August 22, 1918, on account of pain in the left eye. Two weeks before she took the first inoculation of typhoid vaccine, type unknown; the second a week later, and the third the morning of the visit, with the usual reactions. The day after the second inoculation pain developed in the left eye. No history of previous eye trouble or venereal infections. The examination showed a typical iritis, with reduced vision, marked injection, and intense pain. Appropriate treatment. October 7th cured.

CASE V.—Mrs. E., aged thirty-eight, seen in consultation with Dr. A. W. Sterling, to whom I am indebted for the early history and for the privilege of reporting the case. The sight has always been defective, due to a refractive error. Twelve years ago, while nursing a six-months'-old infant, the left eye became affected and she was treated in a distant city. She did not know the diagnosis, but, from the description of the reaction, evidently dionin was used. After several weeks the eye was as well as ever. Her history for infection was negative, but she has always been nervous and had poor health. On July 22, 1918, she received the first inoculation against typhoid, and at weekly intervals the second and third dose, with the usual reactions. Two days after the last inoculation the left eye became slightly inflamed, and thinking it was a cold, she used household remedies, but as it grew worse and the sight became impaired she consulted her oculist. The diagnosis of uveitis with marked vitreous opacities was made at that time. Most careful physical and laboratory examinations, including three Wassermanns, were made to determine a cause, with negative results. When I first examined the patient six months after the onset there was an injection of the deeper scleral vessels, the pupil was dilated, the iris slightly discolored, there were large "mutton-fat" deposits on the posterior corneal surface, and a large vitreous mass which completely obscured any fundus detail.

Later the eye has cleared remarkably under thyroid tablets, but a secondary cataract has developed.

Morax appears to have been the first to call attention to eye complications following typhoid inoculations, for in 1916 he reported his first case of a soldier with old corneal scars dating from childhood, who developed a violent general reaction with high temperature, and herpes of the brow, eyelids, and cornea, the day after the fourth injection of anti-typhoid vaccine. Later he reported his second case of herpes of the face and cornea following the third injection of anti-typhoid vaccine in which the general reaction was intense.

Prélat the same year recorded a case of acute bilateral plastic iridocyclitis following the second inoculation. The Wassermann was positive.

Rousseau later mentions a vesicular keratitis developing after an inoculation of 2 c.c. of triple typhoid vaccine. The general reaction was violent, and the high temperature, headache, and inflamed eye developed the day following the inoculation.

Bussey, of the French Medical Corps, who had charge of the eye service in a section where 22,000 troops were vaccinated against typhoid, reported that five of the men developed ocular lesions thereafter. Two had a nephritis induced by the vaccine; one, a soldier, aged forty-five, developed albuminuric retinitis and died of uremia; the other presented extensive hemorrhage in both retinas. The three other men developed herpes and ulceration of the cornea, but they recovered without impairment of vision. Other articles of a similar nature by Ginestous and Gloagen, appearing in foreign journals, were not accessible in the Library of the Surgeon General.

It is evident that other cases must have developed in the French Army, for in 1917 the French Advisory Military Commission appointed de Lapersonne to investigate whether

or not antityphoid inoculations could produce eye complications. His conclusions were that some eye cases had been reported which were not well established, especially those cases of acute purulent metastatic iridocyclitis due to faulty technic, poor vaccine, or latent infection in the patient, but there were a few other cases which had been closely studied, and there was strong evidence that the eye complications were directly attributable to the vaccine. He believed that the vaccine itself may produce iridocyclitis in one who previously suffered from this affection, especially when of rheumatic or syphilitic origin. He considered that there was a certain analogy between such an occurrence and the eye reactions which occasionally follow injections of tuberculin and arsenical preparations. He further believed that there were certain hitherto unexplained lesions of the optic nerve, optic tract, and ocular muscles which may now be explained by a meningeal irritation or infection due to the reaction of typhoid vaccine. He concluded that in order to admit the action of the typhoid vaccine inoculation, it is necessary that the ocular reaction manifest itself at once or very soon after the injection, and where the violence of the reaction has been demonstrated by the thermometer. And he advises that the patient be subjected to an ophthalmoscopic as well as a medical examination, and it would not be advisable to inoculate syphilitic, tuberculous, or arthritic patients who have had lesions of the uveal tract, especially after the fortieth year.

Bell, of New York, in a recent communication, reports a case of keratitis profunda which developed in a soldier; the acute symptoms followed the second inoculation. The general reaction was profound; all laboratory and clinical examinations were negative, and the case resistant to all forms of treatment. The type of vaccine is not mentioned.

It is known that some cases of acute nephritis and acute exacerbations of chronic nephritis and chronic pulmonary

tuberculosis in our army as well as in the British and French armies, have been directly attributed to the typhoid inoculations. It has been suggested that the number affected is no greater than that normally found in any great body of men who have not been vaccinated. This same argument can no doubt be used against any claim the ophthalmologist might make that eye complications are directly due to these inoculations. But the fact remains that immediately following one of the inoculations certain ocular disorders developed, and circumstantial evidence is too strong to pass it up as coincidental.

One would naturally expect severe constitutional reactions associated with these eye changes; indeed, in many cases they were present, but there were others in which the reactions were normal.

No reason can be assigned for these ocular reactions other than a theoretic statement that the foreign protein contained in these vaccines has a selective action for certain eye tissues, especially the uveal layer, and that certain individuals appear to be extremely susceptible to its action. Just why the reaction in one is more severe than in another is difficult to explain. It can hardly be explained as a reaction of anaphylaxis. The bacterial suspension in the saline solution is comparatively small, yet the general reaction is greater than that of other vaccines, and we are forced to accept the consideration that the endotoxin of the typhoid vaccine is the responsible element.

The *British Journal of Ophthalmology*, in an editorial two years ago, sounded a warning about this same question, and, while we agree with the editor that "it is important that all pathologic phenomena arising in patients immediately or shortly after inoculations should be thoroughly investigated, and that every endeavor should be made to determine if the relation between the vaccination and the subsequent lesions is casual or merely incidental," we believe there is now suffi-

cient evidence to conclude that certain eye complications are directly due to antityphoid inoculations, and that

(1) The causative factor is an endotoxin derived from the antityphoid vaccine.

(2) Observations of sequelæ occurring in other organs following typhoid vaccination lend support to the views herein expressed.

(3) There is an analogy between this reaction and the ocular lesions occasionally seen after the administration of tuberculin and arsenical preparations.

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DISCUSSION.

DR. GEORGE H. BELL, New York: The cases reported by Dr. Calhoun are, I think, rare. I have seen only one, which I showed at the New York Ophthalmological Society, and also at the New York Academy of Medicine. The patient, before he entered the army, had a vision of 20/20. He was inoculated twice with antityphoid vaccine. The first injection was followed by no complications; the second, given one week later, was followed by chill, headache, malaise and a rise of temperature. The eyes became inflamed at the same

time, and he suffered greatly from the light. He was treated in the army hospital for two months. The vision when I first saw him was 5 200 in each eye. He had a deep keratitis. The pupils reacted to light and the eyes were quiet. There were some gray opacities in the deep layers of the cornea. Seen with the naked eye, the opacities seemed uniformly gray, while with the magnifying glass, they might be resolved into dots. The man has now been discharged from the army and receives a pension from the Government. I have had him under observation since September, 1918, and there has been no improvement in vision. Serum and spinal fluid Wassermann tests were negative. He has had three injections of the old tuberculin, which were given in increasing doses without any reaction.

I think that all lesions that may occur after antityphoid inoculation, and can be regarded as due to it, should be recorded. No lesion should be ascribed to the inoculation that does not arise during or very shortly after the series of injections, and after a thorough investigation.

Dr. Walter B. Lancaster, Boston: I have seen no case of uveal inflammation following typhoid inoculation that I recognized, but I have seen a considerable number of cases of neuropathic keratitis. The first was so characteristic that it could not be easily overlooked. The patient was the commanding general of our camp. He had had the typhoid inoculation, which had made him rather sick. When I first saw him, he had herpes on the face. The lesions on the cornea were, therefore, easily recognized as herpetic, *i. e.*, neuropathic. That was early in the establishment of the camp, so that we had occasion to watch for these cases as the recruits came in and received inoculations. We saw, certainly, over twenty cases which my assistant made a record of, and will perhaps report. The condition was not primarily ophthalmic, but neuropathic, and the primary lesion was probably in the ganglia.

FURTHER EXPERIENCE IN THE OCULAR FUNCTIONS OF AVIATORS.

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Increased experience in the Air Service in France deepens the conviction that the original ocular requirements for entrance into the Aviation Corps of the United States are none too strict, even though they do demand a standard of normality. History in all activities of life is replete with tributes to the "masters of fate"—those who have "made good" in spite of, or by reason of, physical handicaps. Such men have one's deepest admiration; but their forte, as a rule, is not in the air.

One of my early experiences in the A. E. F. was sitting on an accident board convened to consider the cause of death of two pilots from a collision in the air. The evidence brought out the fact that the student responsible for the accident had been disqualified in the United States on account of imperfect sight. In training, he had passed through several fields until he reached the one where acrobatics were taught. The other pilot, an excellent flier, was just finishing his turn and was coming out of a virille preparatory to landing. By virtue of the rules of the field and his "dead stick," he had the right of way, but the student with poor sight ran into him without seeing him and both were killed.

The great advance in the airplane, the increase of speed, facility of acrobatics, height of "ceiling," and the diversified duties of the flier, have led to marked specialization in the air.

Before considering the ocular requirements of the aviator

it might be well to speak of the fast-shifting types of air work that existed when the Armistice was signed.

Types of Fliers.—The day chasse, or scout, pilot is the type of flier which is always suggested to the public mind when the word "aviator" is used. He is the "birdman" and the "hawkman" of the press. His duties are various. He must fly to any height, changing altitude instantaneously. It is his duty to protect his own bombers and observers on their special missions. Lieutenant Rath aptly calls him the "mine sweeper" of the air. His altitude varies from "ground strafing" to the limit of the plane's ability to climb. He has to keep a sharp look out in the skies and in all points of the compass for friendly or hostile planes. A spot in the sun neglected may develop into a plane to be fought.

The night chasse pilots, so far, have not proved to be of great military value. While pursuing the enemy, they were often shot down by their own barrage, as instanced by the last air raid upon Paris when many French machines were lost.

The observer is of such importance that Colonel Reille, the able French artillery officer, says: "The principal rôle of aviation is not in dropping bombs, but in observation. The flying machine should not be considered so much as one of the arms of the artillery as one of its eyes—and that eye the better one. The bringing down the enemy's plane blinds his artillery." Richthofen, the German flier, says in his book: "Frequently a photographic plate is more valuable than shooting down a squadron." This type of flying officer is fast developing into a skilled specialist in artillery and infantry liaison, with highly technical knowledge of radio, the making and interpreting of maps and photographs, visual reconnaissance with reports, and aërial gunnery. His work carries him to all altitudes, from dropping a message at 300 meters to a long reconnaissance at 6000 meters. In spite of all that must be seen on the ground, when he is near the

enemy's line, he can spend only one-eighth of his time for this work—the rest of his time must be spent in looking for planes in the air.

Day bombing has been described by Lieutenant Rath as "artillery on wings." The objectives are in the immediate rear of the enemy's lines, zone of activity, and strategic points far within the enemy's country. These distant flights are frequently of four to five hours' duration, and often at an altitude of over 4000 meters, to avoid the enemy's anti-aircraft guns. The targets are often large and well mapped out before leaving the aërodrome. But the bomber must be minutely familiar with the topography of all the country embraced in his mission. Likewise, he must be able to use his maps intelligently. One of our fliers working with the English told of an amusing incident of a very successful night bomber who, on a very beautiful day, went up for a "joy ride" and got lost. He was not accustomed to the topography in daylight.

The night bomber seldom flies higher than 2000 to 3000 meters, but he must be thoroughly familiar with every foot of ground back of his own lines in order to make a landing without really seeing, should that necessity arise. He must be familiar with the topography of the hostile country in order to recognize guiding landmarks. He must be able to recognize all roads, rivers, woods, vineyards, and towns, the last largely by their geometric formations. He must know the constellations and their positions on the compass. Moreover, he must constantly consult his maps and compass. The following contretemps, due to unfamiliarity with the section, is told by some French fliers: An expedition actually bombed Nancy instead of Metz, and finally capped the climax by landing in Luxemburg! Many night fliers have spoken of the very confusing effect of moonlight on the earth-mists, which are so common in France during certain seasons. All

Allied fliers speak of the greater effectiveness of the enemy's searchlights, which leave one blinded for a long time.

The aërial gunner's work has now been taken over by the observer, who has added the use of the machine gun to his other duties.

The aërial navigator is a late product of the war evolved by the necessity of flying in foggy or rainy weather and at night. He directs the flight of his pilot by map and compass. So far there are very few thoroughly trained aërial navigators.

The ferry pilot flies the machine from a central station to some aërodrome near the front, so he does not have to consider the questions of combat or of altitude. In the British service, the ferry pilot usually flew the planes across the Channel.

In the lighter-than-air ship, the altitude is usually not over 300 meters, and the landing does not require the fine adjustment of sight and judgment of distance.

In the captive balloon, the height is usually not over 1000 meters; and while good sight is of great value, the observer has little responsibility in landing, even when he has to take to his parachute. In the free balloon, however, the finest ocular adjustments are necessary.

In regard to sea planes, Major McCombs, who has had much experience in the matter, feels that the pilot should have good muscle balance, stereoscopic vision, and night sight. He says: "The level of the water is difficult to judge, especially when the weather is very calm, and at night." The "ships" are slow to answer the controls, and heterophoria is a common cause of bad landings.

General Considerations.—Color plays a most important part in the success of all types of fliers. On all maps generally used by observers, the woods are green, rivers blue, roads yellow, railroads black, and towns brown. These maps are used for spotting important objects. Sky rockets, with a

parachute, are white, red, or green. And cartridges, with and without parachutes, are of similar colors. Bengal flares, which are used in woods and heavy underbrush, are red and white. The aërodromes use red and green or white lights for home-coming planes, while the planes themselves carry a red light on the port and green light on the starboard side. In a "dog fight," fliers of great experience state it is necessary to recognize the colors on a machine in order to avoid the possibility of shooting down a friend. In artillery work the sense of color is necessary to detect false roads, trenches, and guns which have been camouflaged by colored screens, trees, etc. Infantry contact is one of the most trying pieces of work that an aviator is called upon to do. He must be able to recognize, in addition to everything else, the colors of the various uniforms. An observer tells of a pilot who flew three times over a body of troops before he felt it safe for the machine gun to be used. He had poor color vision, and his final decision was made only when he recognized the enemy helmets. All types of fliers over land are liable to have to select quickly a place for a forced landing. In this connection Captain S. J. Allen, R.A.F., states that good color vision is necessary to detect differences of color on the ground. A light field indicates stubble; a dark-green field, grass, or wet and marshy ground; dark-green stripes running across fields, water or ditches; yellow, sand; and rough brown spots, bumps.

Sight. The value of good sight is very tersely expressed by one of our very successful fliers at the front: "Men with poor vision do not come back." Major McCudden, R.F.C., graphically describes the unseeing pilot: "I shall never forget how that Fokker looked on the 2 C's tail, while the British pilot, calmly flying straight, not looking behind him at all, and no doubt thinking of Blighty, home, and beauty." The increase of vision by practice is emphasized by an American Ace: "I twisted my neck about so continuously,

searching the sky for enemy planes, that the muscles of my neck have become enlarged. Although my sight has always been perfect, I improved very markedly my power of being able to quickly pick up the sight of a plane." While visual acuity is a most valuable asset to every type of flier, it is of less importance, relatively, to the day bomber, to the night bomber, and to the aërial navigator. In the case of the former, the targets are large; with the second, rod vision is more important than that of the cones; in the third type, glasses could be worn with comparative safety.

Should some ocular error become manifest in a pilot who is good otherwise, the error should be carefully corrected, preferably having the correction ground in his goggles. The pilot should, however, be carefully advised of the facts that the goggles might be blown off, be broken, or become fogged or soiled with oil or water.

One-Eyed Men.—All experienced men with whom I have talked agree that a one-eyed man should not be admitted to the Aviation Corps. However, when a successful combat pilot loses an eye, the question becomes an important military one, and the matter is now under consideration by the British Research Committee. The objections to returning him to duty are based upon the facts of a diminished field of vision, and the impairment of the ability to judge speed and distance which causes difficulty in landing. The visual field is of lesser importance, owing to the nature of the work (most aptly described "rubber neck") which keeps one moving his head in all directions in search of planes. The difficulty in landing is more serious. It is recognized that some men cannot be trained to use one eye. On the other hand, a number of one-eyed pilots in the British Service were salvaged for their country. However, the gradual returning ability to take off and to land could be tested with a fast ship at the aërodrome. Professor Rivers, of the British Research Committee, in a personal conversation, laid great stress upon

the economic value of the training, judgment, and experience in seeing of the combat pilot. According to a British authority, one R.F.C. cadet out of four reached the air over the enemy's line. In our service, approximately one-half of the observers and one-third of the pilots got to the front.

The first few trips over the line are the critical ones. Other considerations are: the length of time it requires to make an aviator, that all good fliers are not good in combat, and that an aviator with perfect sight has to learn to use it understandingly.

Captain Rickenbacker, the foremost American Ace, telling of his first trip over the enemy's lines, says: "Major Luftberry asked what had been seen; but we both repeated, as easily as we could, that we hadn't seen any other aëroplane in the sky. 'Well,' said Luftberry, 'One formation of five Spads crossed under us before we passed the lines and another went by about fifteen minutes later and you didn't see them, although neither of them was more than five hundred yards away!'"

Color Vision.—The various activities in which the recognition of colors plays an important part have been mentioned. It is of great help in following the topography of the country in all types of fliers. However, if a successful color-blind pilot is discovered in classification, he could be used as an instructor, ferry pilot, or a night bomber, if only white lights were used at his aërodrome. Major McAlester, who was for a while stationed at the observers' school at the Second A. I. C., recommends very strongly the necessity of taking the color fields as well as the central color sense.

Muscle Balance.—Good muscle balance has been considered of great importance by those who have thoroughly studied the subject. Halben, in 1914, laid emphasis upon the danger of the laming of an eye muscle, thus producing a false projection and a disturbance of orientation. That the

great importance of good muscle balance has been recognized is shown by the fact that a school of heterophoria has been established in England under the supervision of Major Clements. Here many pilots who have been unsuccessful in training have been salvaged by his painstaking work. During the period from August, 1917, to July, 1918, 84.5 per cent. of the officers turned down for bad landing were successfully treated by training the ocular muscles. In two subsequent groups, 50 per cent. were successfully treated in one group, and 92.8 per cent. in the other. For ocular training, Major Clements uses largely the Worth Amblyoscope. The importance of this subject in our service has been emphasized in the ophthalmologic departments of the medical research laboratories in this country and in France. In addition to well-balanced muscles, strong convergence, and accommodation, we have felt the necessity for measuring the rapidity of accommodation in changing the point of fixation, and for comparing the records of the two eyes. At the last meeting of this Society, Professor Ferree read a most valuable paper upon "The Inertia of Adjustment of the Eye for Clear Seeing at Different Distances." Major Berens has done much work upon an apparatus to make these tests, and also upon other instruments for studying monocular and binocular parallax in the judgment of speed and distance. Treatment of these muscular weaknesses consists in removing all underlying causes, in rest, in muscle exercises, and, in rare instances, in operative procedures. The wearing of prisms is risky.

Stereopsis.—The value of stereoscopic vision has been questioned, owing to the recognized fact of the predominant eye, and the fact that a few men with one eye, and some with poor stereoscopic sight, have been successful fliers. However, in our opinion, good stereoscopic vision is of great value in the judgment of distance in making a landing. It is also of value in studying stereoscopic plates. The cards with

stereoscope as used in the selection of the flier, take up very little space and they are easily and quickly used. However, the most practical test that I have seen is the one used by Professor Spearman. In brief, it consists of two fixed vertical outside wires, a middle movable wire attached to a millimeter scale. This wire is attached to an endless cord running over a pulley at either end. The background is a milk glass lighted by electricity that can be increased or diminished. The observer sits facing the wires at a distance of 10 feet. He looks through an aperture and moves the central wire back and forth until it seems to be on the same line with the two outside wires. He is allowed twenty seconds to make each reading, and his average is taken from six readings. His accuracy is recorded on the millimeter scale. The method of making this test can be improved by making shorter the period allowed for observation, by reducing the twenty seconds to from two to five seconds. In Professor Spearman's latest apparatus, the comparative test objects are formed by the edges of two pieces of milk glass set at an angle. Professor Spearman has found correlation between success in flying and good stereoscopic vision taken by this test.

Retinal Sensitivity.—Study of the various methods of testing retinal sensitivity impresses one with the fact that no "short cut" to accurately testing this function has been devised. Our Italian allies use a very good test of the contrast sensibility. The test-object is a series of incomplete circles of different sizes on a background in which there is an increasing diminution in the shade difference between the circles and the background. There are a number of more accurate tests, but they require from one to one and one-half hours for each subject. Professor Spearman has a new apparatus. He first produces a uniform bright adaptation by having the subject face a white screen illuminated by a 1000-watt lamp. He is then kept in complete darkness for

two minutes before the testing begins. He then tests the threshold sensitivity by throwing different stimuli upon the screen with his "night vision box." At the Medical Research Laboratory, Mineola, L. I., Captain Cobb has devised an excellent "adaptometer" which he has described in full. He points out facts that have already much impressed us when considering the classification of the night flier, and our want of exact knowledge concerning the photometric value of objects to which he is exposed. One has to consider the varying light values of stars, clear moonlight, misty moonlight, reflections from roads, rivers, towns, and the "blinding" effect from tracer bullets, lights at aërodromes, skyrockets, cartridges, flares, bursting shells, and searchlights. Practically, it would seem that one who has a good average speed of adaptation with an average recovery from exposure to light for a brief period, would make a safe night flier, from the visual standpoint. An accurate test of this type requires an hour or more, but in classification of fliers for night work it is well worth this expenditure of time and care. McCudden, speaking of a pilot flying at night, says: "He left the ground in the dark to fly 20 miles across France to an aërodrome, and as soon as he was off the ground he flew through the side of a house. The only thing that was undamaged was himself."

Simple visual reaction time, which is so important to the acrobatic flier, is not of so much importance to the combat pilot unless associated with cool decision and accurate muscular coördination. Richthofen, who was credited with bringing down 80 Allied fliers, says in his work, "The Red Battle Flier": "It followed that the victory would accrue to him who was calmest, who shot best, and who had the clearest brain in a moment of danger. We have lost many good fighting pilots through their getting excited and dashing headlong into an unequal combat." The most successful fighter is not the one who fires the first shot, but the one who

carefully lines up his sights upon the enemy and who downs him with the first bursts from his machine gun. In other types of fliers a strong physique is more important than a rapid reaction time, on account of the physical strain to which they are exposed. The French authorities give the average visual reaction time as 19 100 seconds. The average of these tests made in the laboratory in France with the d'Arsonval chronoscope is: students, 19 100; monitors, 17 100; testers (among whom there were some remarkable stunt fliers), 18 100; American fliers from the front, 20 100, and French fliers, 21 100.

CONCLUSIONS.

1. Absolute normality of the eyes is one of the greatest physical assets that a flier can possess.

2. Affections of only passing inconvenience on the ground are serious in the air, such as scintillating scotoma, muscæ volitantes, photophobia, epiphora, heterophoria, and, for the night flier, poor dark-adaptation.

3. A successful combat pilot with trained air vision who loses one eye may, during the exigency of war, be seriously considered for a return to flying status, under certain conditions previously mentioned. This, however, should be considered only when the confidence is unimpaired and there is keenness to get back.

4. In classification, a cycloplegic should be used and the fields for form and color taken and recorded.

5. The regular eye reëxamination of the flying officer should be made every two months, at least.

6. The simple visual reaction time is of great value to the chasse pilot if associated with cool determination and caution.

In spite of the painstaking work of our Allies and of our own laboratories and the splendid record of this work, should a questionnaire be framed asking what was the most impor-

tant lesson learned in the A. E. F. concerning the ocular problems of aviation, I would answer, "How much there is to learn and how little is known!"

DISCUSSION.

DR. ALEXANDER DUANE, New York: Dr. Wilmer's paper brings to my mind one point which I tried to emphasize this morning, that we must always consider whether the tests we make actually show what we wish to determine, *i. e.*, a man's real availability for the work that he has to perform. In other words, are the man's eyes, when tested, functioning under the same conditions as they do in actual practice? If they are not, then our tests, unless we make allowance for their fallibility, give us false ideas. To particularize,—Our ordinary visual test is one of sharp contrasts, of black letters on a well-illuminated white ground, or *vice versa*. Never, in actual practice, has an aviator or signalman to deal with contrasts of this sort. On the contrary, he is all the time concerned either with objects (flags, semaphore signals, ordinary lights, moving bodies of men, roads, etc.) whose contrast with their surroundings is extremely slight, or else with those (*e. g.*, searchlight signals) in which the contrast is extremely vivid. Hence, my contention that, as has been done in the laboratory at Mineola, whose methods I have observed with the greatest admiration, our laboratory tests should be used only as a preliminary examination, to eliminate the obviously unfit; the ultimate decision as to fitness resting upon examinations made under service conditions, and with objects in their service relations.

CAPTAIN HARVEY J. HOWARD, M.C., Mineola, L. I.: The paper of Dr. Wilmer's is of especial value to those of us who have been working in the air service. In response to a request from the commanding officer of the laboratory, we have been working on recommendations for revision of the eye tests to be applied to applicants for the aviation service. The report concerning these recommendations was placed in the commanding officer's hands this week. Inasmuch as my paper of this afternoon will mention two or three things that I should like to talk of here, I shall not refer to them now, but will only say that in the above-mentioned report we have

recommended strongly the use of a cycloplegic and a careful refraction of all applicants; also the taking of the peripheral color-fields, in addition to testing for central color vision. There seems to be a strong consensus of opinion among flight surgeons, as well as among fliers themselves, that good peripheral color discrimination is necessary for all aviators. A few weeks ago Major MacAllister, of Kansas City, recently returned from France, made us a visit and told us, in very comprehensive terms, of the great value of good peripheral color vision especially for night fliers.

DR. CONRAD BERENS, JR., New York: In the beginning of our work in active service with the American Expeditionary Forces, we arrived at Issoudun, the "Mud-hole of France," and went from there to the Third Aviation Instruction Center, where naturally no preparations had been made for doing research work. After a day or two the ophthalmologic work was begun in the eye, ear, nose, and throat room of the hospital. We soon found it unsatisfactory, because we upset the hospital routine, and we therefore transferred our apparatus to the end of an influenza ward, curtained off by means of sheets, and made a dark room by hanging gray army blankets. While the influenza patients were there we had two stoves, and after they went, only one. It was often so cold that it was impossible for us to handle the instruments properly. At about the time the armistice was signed we moved into the newly constructed laboratory and had a well-equipped room for the ophthalmologic department. I mention these things to show the difficulty of doing research work under service conditions, and in the hope that the research at Mineola will be carried on and developed, so that it will not again be necessary to attempt such work while at war.

DR. ALLEN GREENWOOD, Boston: I cannot let this occasion go by without rising to bring to the members of the Society a realization of the perfectly colossal and wonderful work that Colonel Wilmer has performed for American aviation. It was my pleasure and privilege to assist in this by requesting that a cable message be sent calling for aviation experts to be sent to France. That was one of my first acts in the office of senior consultant. I realized the necessity for this in a minor degree, but it was only after my visit to

Issoudun, to look over the work that Colonel Wilmer was doing, that I appreciated the vastness of the task and how wonderfully it was being performed. I want to express publicly here to him my tribute for what I consider one of the finest pieces of work that has been performed in the American Expeditionary Forces in France.

DR. NELSON M. BLACK, Milwaukee: The point that Colonel Wilmer brought up in regard to the determination of visual acuity, and that of Dr. Duane concerning the examination of applicants for signal work, is the same that has been considered in connection with the attempt to determine visual acuity of men in railway service: *i. e.*, that office tests are not comparable to field tests. The objection to field tests has been that they consume too much time, and weather conditions are a factor in determining when and how they shall be made; but in every instance the fact that office tests do not bring out the actual visual acuity of men, especially for railway service, has been forcibly brought to our notice. The necessity arises for uniform methods of testing vision in these various occupations or professions, so that the test shall be in conformity with the conditions under which the men have to use their vision. Tests in accordance with the conditions under which the men fly are necessary in aviation examinations. The same applies in examining naval recruits, as well as in the railway service.

DR. LUCIEN HOWE, Buffalo: Before calling on Colonel Wilmer to close the discussion, I cannot refrain from saying that even for the casual visitor to the laboratory it was interesting in the extreme to see the methods employed and their scientific accuracy. It was my privilege to go there quite frequently, at first from curiosity, but afterward as a student. I want to pay my tribute to the enthusiasm of the workers and to the great value of the results obtained.

DR. W. H. WILMER, Washington, D. C.: I wish that I had the aptitude of our President and Dr. Greenwood for gracious speech, in order that I might make a suitable reply. I do not attribute these results to myself alone; it was largely due to the men associated with me that the work was so well

done. The success of the work was due to their loyal assistance.

With regard to what Dr. Duane has said, he is always practical as well as scientific. The fact he brought out, that the laboratory or office test does not give a true estimate of visual acuity, we realized more and more. We did use the Snellen type, but we also employed the Ives visual apparatus. That is a good clinical test.

In the ophthalmologic department they often took a man and made him stereoscope objects, just as he would have to do in landing, using wires, buildings, and trees just the things that he would have to avoid. We tried to make the examination practical. We realized that a man might be physically perfect and perfect in psychologic reaction, and yet not be a good fighter or flier; and, the reverse of this, we recognized that a man might not be in the best physical condition, but possess an aggressive spirit, a spirit of service, which would make him excel a man far superior to himself in physical respects. In this connection I cannot refrain from mentioning Guynemer, the French aviator, who had rarely been able to go to school for a consecutive year. By many tests he would have been considered nervously unstable. He was a good shot, but not strong physically. When he became an aviator, he was shot down eight times and had innumerable accidents; but that wonderful spirit of his conquered all obstacles, and he was soon up and back again. On one occasion he had just been shot down, and was supposed to be at home recuperating; but he slipped away to a neighboring aërodrome, and went up without a machine gun and exposed himself to a German fighter, until the latter had fired 500 shots at him. Then he came back. When rebuked for his foolishness, he said: "It was not so foolish as you think. I have been told that a man who is shot down loses his nerve; and I wanted to see whether I had lost mine. I have not." The physical tests are important, and also the reaction time; but if, in living intimately with a man, you find that aggressive spirit, you have a man who is fit to fly. His very will nullifies the other shortcomings.

RESEARCH WORK IN OPHTHALMOLOGY AT THE MEDICAL RESEARCH LABORATORY OF THE AIR SERVICE DIVISION OF THE SURGEON GENERAL'S OFFICE AND ITS BEARING ON THE TEACHING OF OPHTHALMOLOGY IN AMERICA.

WALTER B. LANCASTER, M.D.,
Boston.

Report on the work done at the Medical Research Laboratory at Mineola during the first period of its existence was made to you last year in the memorable addresses of Colonel Wilmer and Captain Berens. Soon afterward they went overseas to establish the work of the laboratory in the American Expeditionary Force, taking with them many of the ophthalmologists from Mineola. The second period dates from that time, about August 1, 1918, and runs until the time when the discharge of officers following the signing of the Armistice made necessary a third partial reorganization of the Ophthalmological Department of the Medical Research Laboratory, about the end of the calendar year of 1918. The third period brings the work of the laboratory to date. The first period lasted about seven months, the second five, and the third about six months.

It is important to understand what the work of the Ophthalmological Department of the laboratory was during the second period which my report summarizes. The title, "Medical Research Laboratory," implies that most if not all of our time was devoted to research. This was by no means the case with the department as a whole.

The laboratory at Mineola was the center of a group of branch laboratories, constantly increasing up to the cessa-

tion of hostilities. We had to supply the personnel for these branches, plan and oversee their work. Supplying the personnel meant not only securing the officers and men to make up these units, but teaching and training them at the Mineola Laboratory before sending them out, and then following up their work in detail, all their reports being revised and corrected at the central laboratory. Thus the most pressing work of the Ophthalmological Department of the Medical Research Laboratory was the securing, teaching, and training of officers and men for the work of the Air Service Division of the Surgeon General's Office, on the one hand, and, on the other, the carrying on of the special classification work for which these units were designed.

The special work on which these units were engaged was the classification of all the aviators according to the altitude to which they could safely be permitted to fly. This classification was made by putting the candidates through a so-called "Rebreathing Test." The chief accomplishment of the laboratory during the first period of its existence was the devising and perfecting of this test. The chief accomplishment of the second period was the carrying out of a large number of these tests.

In addition to training ophthalmologists for work in these units, we were engaged, during the second period, as well as during the latter part of the first period, in teaching flight surgeons the ophthalmic part of their work. This was done by lectures and demonstrations.

Thus the research work was forced to the third place, instead of occupying the first place, as might have been assumed from the title of the laboratory.

Research Work of the Laboratory. In considering the various possible courses which might be laid out for the research part of the work of the Ophthalmological Department of the laboratory when the first régime came to an end,

and I was given the task of "carrying on," it seemed on the whole wisest to turn from the extensive to the intensive type of investigation, and to concentrate our efforts on a few subjects, pursued as exhaustively as our facilities and abilities would permit. The time seemed ripe for a critical review of some of the conclusions previously reached at the laboratory and for an attack on some of the problems by more refined and quantitative methods, for example, problems of light sense and of stereoscopic vision.

It was easy to make a list of subjects for investigation; the hard part of the program was the securing of ophthalmic research workers to carry on the investigation. At the start there was only one research worker available—Captain P. W. Cobb. To be sure he was a host in himself, since he was a trained and experienced laboratory worker in ophthalmology—the only one in the country who was an all-time research laboratory worker in ophthalmic physiology when the war broke out. Major Sherman, Lieutenant Dunnington, and myself were giving all our time to the indispensable administrative, teaching, classification, and clinical work outlined above. As sixteen months had passed since war was declared, a heavy drain had been made on the ophthalmologists of the country, and it was a very different proposition to secure workers from what it had been earlier. Application was made to the Surgeon General for twenty ophthalmologists, and personal solicitation was made by the head of the Ophthalmological Department of the laboratory to various ophthalmologists in different parts of the country who had not yet entered the service for one reason or another, and whose coöperation it was hoped we might secure. Many of these could not be released by the institutions to which they were bound—medical schools or hospitals which had already made sacrifices to the limit; a few, very few, seemed not to appreciate the duty or privilege of doing their bit.

The call for twenty ophthalmologists when so many had

already been assigned by the Surgeon General seemed a well-nigh impossible one to meet. This application was made to Colonel Parker, the head of the Ophthalmological Section, who turned it over to Lieutenant Colonel de Schweinitz, who was in charge of the ophthalmic personnel, and in a few hours the list was supplied. Many weeks passed before the various transfers and arrangements could be carried out; but before the Armistice was signed we had completed our quota of officers for both the classification work and the research work. In the meantime research work did not flourish.

Realizing our inexperience in research work in the physiology of vision, we laid special emphasis, first, on the importance of a thorough search by each research worker of the literature of his special topic—the importance of this is obvious, yet it is the most frequently neglected of any of the fundamental principles of research; second, on the importance of seeking the advice and criticism of workers in other departments of the laboratory, especially the psychologists and physiologists, who were in many cases experienced research workers and had carried on investigations dealing with the visual functions. The readiness of these departments to lend their coöperation was one of the pleasant features of the laboratory.

With the exceptions of Captain Cobb and Captain Dolman, none of us had had training in laboratory research work in physiologic optics or ophthalmic physiology or the allied branches of psychology, although the work done by various members of the staff in other branches of ophthalmology, such as the clinical, the operative, and the pathologic branches, is well known and was, of course, the reason for selecting them.

Most of those who did any work at the laboratory found the field of the physiology of vision exceedingly interesting and of great practical importance to ophthalmologists.

How could it be otherwise? Many were surprised to find how much had been done, as appeared when a study of the literature of any subdivision was made. This was partly because the writers in these fields have been chiefly psychologists, physicists, and physiologists. They publish their work in channels not commonly studied by oculists.

No school for teaching ophthalmology but has its departments of pathology, clinical ophthalmology, and operative ophthalmology; but physiology is limited to refraction,—admittedly the most important branch,—while a smattering of binocular vision, and less than a smattering of light sense, color sense, and the psychology of vision, are given at most centers for teaching ophthalmology in this country. Were there one or two centers where research work and teaching of the physiologic side of ophthalmology were being adequately carried on, the influence would permeate the whole of American ophthalmology: the character of the general teaching would be greatly influenced, and so would the writings of American ophthalmologists. It would become impossible for any one with such wild ideas of accommodation, for example, as have been emanating from the largest university in the country, to get a hearing, much less any recognition.

Selection of Subjects for Investigation.—I like to classify the visual functions under three heads: (1) The percipient or sensory functions; (2) the adjusting mechanisms; (3) the psychic side of vision.

A survey of the work already done, both in the Hazelhurst Laboratory and in the branch laboratories, showed that the vast majority of failures of the visual function were due to a breakdown of the adjusting mechanisms. This is what a study of eye-strain in civil life would lead one to expect. Eye-strain is due not to failure of the retina or optic nerves, etc., to perform their sensory functions, but to failure of one or more of the adjusting mechanisms.

The three chief adjustments which our eyes have to make are: (1) Fixation; (2) focusing or accommodation; (3) adaptation or adjustment to light intensity.

Fixation is probably the most frequently at fault in aviators, judging from the reports sent in from branch laboratories. Fixation is a binocular affair, and so somewhat complex, and comparatively recent in its phylogenetic development. It belongs to the class of sensorimotor coördinations, which, as pointed out by Major Dunlap, the psychologist, are the functions which are especially vulnerable to asphyxiation—high altitudes.

It was obvious that the function of fixation and its defects, as shown by heterophoria and diplopia, deserved investigation. The papers of Captain Dolman and Lieutenant Buchanan relate to this branch. We have to thank Dr. Howe for urging us to investigate these special topics.

The second adjustment, that of accommodation, is important, because when it fails, the image on the retina is no longer distinct, and so visual acuity drops, it may be, seriously. The work of Ferree and Rand with the tachistoscope, which was presented before this Society last year, offered a promising opening for work on accommodation. Captain Wheeler and Lieutenant Goodall have been working on this subject.

The third adjustment, that of adaptation, was not thought to be a frequent cause of failure of visual function in aviators; but too little was known about it. Its bearing on night flying, which was so important in warfare, was obvious. Hence it was included in our list. Dr. Cobb will report on this.

Under the third heading, the psychic side of vision, the subject chosen was the estimating of distances. This is exceedingly important in making landings, as well as at other times. Most of the accidents occur in making landings. It had been freely stated by various writers that

stereoscopic vision was exceedingly important, if not indispensable, to the flier. This seemed doubtful to me, for these reasons: (1) Because it was not uncommon to meet a flier who lacked stereoscopic vision, and yet who maintained—and justly so—that he made good landings; (2) stereoscopic vision enables us to estimate relative distances with great accuracy when the objects are near us; but the power to discriminate diminishes with the square of the distance, and at the comparatively long range at which the flier works, this means of judging distances is surpassed by other methods of judging. Captain Howard will report on this subject.

Our conviction of the importance to the aviator of a high degree of visual acuity, a conviction which reports from our colleagues at the front only served to emphasize, led us to plan an investigation to determine the value of a method of estimating hypermetropia without the use of cycloplegia. The results were encouraging, but a later personal communication from Captain Berens led me to believe that it would not be so difficult as I had anticipated to examine a very large number under homatropin if his method of systematizing the examination were followed.

An investigation of the importance of normal color sense was planned, with the expectation that it would show that under the conditions of altitude, distance, and aërial perspective which obtain in scouting, etc., color vision would be found to be far less important than light sense, and less important than commonly believed in making out topography, though, of course, indispensable for signals, etc. This and several other lines of research requiring actual flight conditions for satisfactory study had to be put off because we did not succeed in securing facilities for research in the air. It was gratifying to hear Dr. Duane this morning emphasize this point, the importance of the light sense in naval signalmen, who also are dealing with the perception of distant objects under conditions of atmospheric haze.

I left the laboratory before these investigations were much more than started, and am as much interested as you are in hearing the results as they are to be reported at this meeting.

In spite of all the handicaps, the work done, especially during the first and third periods, speaks for itself, and shows that, given the facilities and stimulus, first-class work would surely follow.

It is to be hoped that the laboratory, now so well established, will be continued and become a center for research and instruction, such as American ophthalmology so sadly needs. This need is forcibly and disagreeably thrust upon the attention of those who serve you on the American Board for Ophthalmic Examinations. Dr. Jackson yesterday, at the American Medical Association section meeting, emphasized what we have so often spoken of before, the deplorable weakness of candidates in nearly all departments of the physiology of the eye. We have heard the well-deserved words of praise given to the ophthalmologists who served in the army for the good work they did. A candid and frank statement of the other side would, I regret to say, show that incompetence and almost utter lack of training were wide-spread. I admit this is not limited to the ophthalmic branch of medicine, as instance the recent statement of Lieutenant Colonel Foster: "There can be very little question that medical inefficiency is much more wide-spread than we have been willing to admit." —(*Jour. A. M. A.*, June, 1919.)

I have said that this state of affairs among ophthalmologists is deplorable. If we allow it to continue, it will become disgraceful. When candidates ask us what they can do to remedy their deficiency we are at a loss what to say. The fact is that the physiology of vision and physiologic optics are not adequately taught anywhere in this country, and one of the reasons is that there are no available teachers. Hence it is that some of us hope that the laboratory will

continue its existence, not perhaps in the same location, but in a better one.

It might be possible for arrangements to be made whereby any qualified worker could go for a period of a month or a year, or as long as needed to carry out a piece of investigation, with the resources of a government laboratory and under the guidance of a competent and experienced head. Since some military organization would be essential under the conditions, it might be arranged for those who wished to go as temporary workers to become members of the Medical Reserve Corps, and be ordered into active service and sent to the laboratory for such time as the proposed work would require.

I hope that the President and members of the Society will voice their opinions as to the wisdom and the possibility of continuing the laboratory as a permanent center for research and for training teachers in the physiology and psychology of vision.

A TEST FOR THE JUDGMENT OF DISTANCE.

CAPTAIN HARVEY J. HOWARD, M.C., U.S.A.,
Mineola, Long Island, N. Y.

The much-discussed question of the judgment of distance has suddenly come to have, through the advent of military and naval aviation, an important and practical application. The literature on the subject is voluminous. One finds, however, that it is rich in the amount of theory from the physiologic, psychologic, and philosophic viewpoints, but exceedingly meager in experimental data, most of which were published several decades ago. It is the practical phase and consequently the experimental data which most concern those of us interested in the examination and classification of applicants for the aviation service. We are eager to know how and why we are able to judge distance, but our chief object is to learn what the individual ability of men along this line actually is.

Status of the Present Test.—The test for the judgment of distance is referred to in our aviation manual as the test for "stereoscopic vision." For this purpose a hand stereoscope, with specially made sets of stereoscopic charts, is used. In the majority of cases this test is satisfactory as far as it goes, but it does not permit of any except rough distinctions. No accurate classification, based on a subject's relative ability, is possible. Either he projects all the pictures fairly accurately or he gets no projection at all. On this basis he is rated as "normal" or "not normal." Also the ability to fuse stereoscopic pictures is impossible for some individuals who have very good judgment of distance. Artificially produced stereoscopy with them is an act wholly new in their

experience: the harder they try, the more confused they become. Some finally learn the trick, others never do, so it is safe to assume that, among the applicants who were excluded on account of this technical inability, there must have been some who had good judgment of distance and consequently were unjustly debarred from the service. Nor does the stereoscopic test preclude the possibility of an overzealous applicant having learned the respective positions of the objects in the picture prior to his examination. Indeed, such an explanation is the least critical and perhaps the most ethical way of accounting for a number of cases of faulty binocular vision recently found among the fliers, especially since all the evidence pointed to the fact that this was not a recent condition.

On the grounds that there are fliers now in the service with faulty binocular vision and a few with only monocular vision, some examiners have questioned the absolute necessity of binocular single vision as a preliminary requirement. Upon sober reflection, however, one must conclude that the knowledge that a number of men with faulty binocular vision have been admitted to flying service and are still living does not constitute a proof that even a larger number have not met an unnecessary death on account of having wrongly been permitted to fly. It is error in judgment of distance in landing a plane that has caused the great majority of deaths among cadet aviators. The Manual of the Medical Research Laboratory, 1919, in discussing this subject, says: "Speaking of error of judgment in flying as a cause of aëroplane accidents, Anderson states that this accident may occur in getting off the ground, in the air, or when landing. To 58 crashes in the 'V' series, this accounted for 42—4 in getting off the ground and 38 in landing." It is impossible to make postmortem confirmation of the binocular vision of those unfortunate fliers, but it seems logical to insist on a safeguard that seems so obviously necessary.

In view of the criticism of the hand stereoscope as a satisfactory test for the judgment of distance, it fell to my lot to find or devise a test which would be free from that criticism. In order to undertake the subject with the proper background it has been necessary to go into the subject of the judgment of distance rather fully. I shall endeavor, then, to give a brief summary of that subject, with reasons for deciding upon a certain form of apparatus which seemed to fulfil the requirements which I sought and had the added advantage of being extremely simple in construction.

Consideration of Factors Involved in Judgment of Distance.—Judgment of distance is dependent upon several factors. Some of these factors operate for both monocular and binocular vision alike. The others act only when binocular single vision is present. In brief, the latter possesses all the factors that monocular vision has, and in addition has at least two others. The distinctions may be represented as follows:

A. Factors common to both binocular and monocular vision. 1. Size of the retinal image. 2. Accommodation. 3. Motion parallax. 4. Terrestrial association: (*a*) Linear perspective; (*b*) overlapping of contours; (*c*) light reflections and shadows. 5. Aërial perspective, *i. e.*, the changes with respect to color, brightness, and contrast which distant objects undergo on account of variations in the clarity of the intervening atmosphere.

B. Factors operating only with binocular single vision: 1. Binocular parallax. 2. Convergence.

In employing a test for the purpose of classification it is necessary to utilize only that factor or those factors which operate to make for an individual difference in ability. All other factors should be eliminated in such a test. Is it possible to isolate and thereby examine the factor showing the most individual characteristic? The following argument should answer this question:

Motion parallax is produced either by movement of the

observer or by objects within his field of vision. For that reason it may be considered an artificial factor employed only to enhance the already existing facility. It should, therefore, be eliminated as a factor not related either to innate or to acquired individual ability.

Factors external to ourselves which assist all of us equally, such as terrestrial association and aërial perspective, should also be eliminated for the same reason.

Factors which operate only for short distances and either not at all or only very slightly for distances of six meters and over, do not need to be considered when examining prospective aviators. Therefore, accommodation and convergence should be eliminated.

The two remaining factors are the binocular parallax and the size of the retinal image. It is possible to obtain the relative values of these two factors by using the same test apparatus, first with two eyes and then with only one eye. In the first instance both factors may operate together; in the second instance the binocular parallax is eliminated and only the size of the retinal image can operate. This latter is practically as important a factor with one eye as it is with two. If by comparison it be found, on the one hand, that the results are the same or approximately the same, it is obvious that the size of the retinal image which operated in both tests is the important factor. If, on the other hand, it be found that the binocular test produces a far more delicate discrimination than the monocular, we are forced to the conclusion that the binocular parallax is the more important factor and the size of the retinal image is negligible or practically so. The results of just such tests were obtained and have been tabulated in this report and conclusions deduced therefrom.

It may be wise, at this point, to correct what may result in an erroneous impression from the foregoing statements. There has been no intent to belittle the other factors to the

advantage of the binocular parallax and the retinal image. These other factors must play a very important part in judging distance properly. It may be that, taken as a whole, they assist us as much as the factors specially referred to. It may also be true that our experience teaches us to use these factors more and more, especially when suddenly deprived of the binocular parallax through the loss of an eye, but it must be maintained that, except for convergence and accommodation, they are factors extraneous to the individual and do not represent that difference in ability characteristic of him. In addition they are not constant, but vary greatly with atmospheric changes and environment, whereas binocular parallax is subject to no variation *per se.*

The Problem of a Suitable Apparatus.—The problem, therefore, was to devise an apparatus which would eliminate all factors except the binocular parallax and the retinal image. The test should also permit of our common, everyday method of depth perception without interposing the feat of fusing stereoscopic pictures. The apparatus then should be employed at a distance of at least six meters. The test should be as conventional as possible, simple, and permit of fine discrimination. Finally, to avoid the possibility of motion parallax, a head-rest should be used.

In searching the literature I was fortunate in finding the description of an apparatus devised by Brooksbank James,* of England, in 1908. With a few modifications and the addition of a head-rest this seemed to meet all the requirements.

Description of the Apparatus.—The framework consists of three sides of a box—the back, the bottom, and the front. The inside measurements of the front and back are 58 cm. high and 75 cm. wide; the floor is 55 cm. from front to back and 75 cm. wide. The anterior and posterior surfaces of the

* "Measurements of Stereoscopic Visual Acuity," Lancet, June 20, 1908, p. 1763.

front partition and the floor are painted a dead black. The anterior surface of the back partition is covered with a sheet of dead white cardboard. In the middle of the front partition a window is cut, 20 cm. wide and 12 cm. high. The upper margin is 38 cm. from the top of partition.

Extending from front to back a board, 12 cm. wide and 2 cm. thick, is permanently fixed over the center of the floor. Before being fixed this board is marked off with a scale 0.5 cm. apart. Two parallel lines 6 cm. apart are also drawn the length of the board. Where the scale and parallel lines cross, small holes are bored with an electric drill. The holes are made for the purpose of carrying upright wooden rods or dowels. These rods, which are 1 cm. in diameter and 26 cm. long, are smoothed with sand-paper, painted black, and carefully modeled at one end to fit into the holes.

The rods are illuminated by indirect light from the white surface of the background. The source of light is a 75-watt nitrogen lamp carried by a flexible goose-neck attached to a floor-stand. The lamp is set about 20 cm. in front of the back partition, near to the top of the apparatus, but low enough to be hidden from the view of the subject to be examined. A Hubbell aluminum reflector casts the light-rays onto the white background at an angle of 45 degrees.

A cardboard screen is placed behind the window to prevent the observer from watching the operator adjust the rods. The latter stands at the left side of the apparatus, which is placed upon a table adjustable to any required height.

The only remaining apparatus is a Trolland head-rest, attached by a clamp to the edge of a table six meters in front of the box.

Method of Examination (Fig. 1).—The test is carried out in a dark room with the source of light as indicated above. The subject or observer is seated in a chair, with his head securely but comfortably fixed in the head-rest. The appa-

ratus is adjusted so that the eyes of the observer are exactly six meters from the zero mark or middle of the cross scale

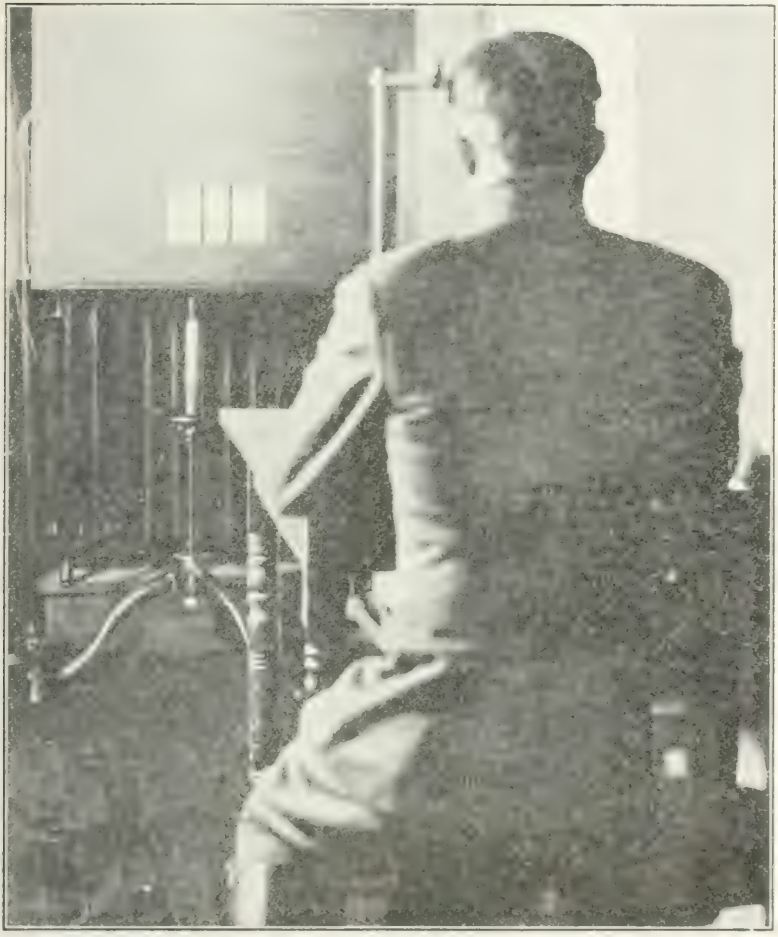

Fig. 1.—A subject making an observation.

on the rod-carrying board. Adjustment is also made, so that the observer's eyes are at the same height as the middle of the window. This latter precaution is necessary to avoid

any chance of linear perspective entering in. Therefore, when the rods are placed in position and the screen lifted, neither the bottoms nor the tops of the rods are visible, but only the middle one-half or thereabouts.

When everything is ready, the observer is told to fixate a point near the center of the screen. The screen is suddenly raised, giving practically an instantaneous view of the rods. The observer is required to state which of the two black rods is nearer to him, the right or the left. He is informed at the beginning of the test that at no time will the rods be set in the same reference plane, *i. e.*, they will not be equidistant from his eyes. His judgment is, therefore, reduced to the simplest terms, viz., which rod is the nearer. At the same time all effort is made to deceive him as to the relative positions of the rods. A pack of 20 blank playing cards are lettered, ten of them "right" and ten of them "left." These cards are shuffled before the judgments are taken at each station, and the positions of the rods determined in the order indicated by the cards.

Twenty judgments are taken at each of five stations. As a rule, the first station observed represents the 30 mm. depth difference, *i. e.*, when one rod is in a reference plane 6000 mm. away from his eyes and the other 6030. If the 20 judgments are all correct, the observer is tried successively at the 20 mm., the 15 mm., the 10 mm., and the 5 mm. stations, or until it is apparent by the number of wrong judgments that he is merely guessing or actually projects the farther rod nearer than the other. If the judgments at the 30 mm. station are not all correct, the observer is tried at the 40 mm., the 50 mm., the 60 mm., and the 90 mm. stations, etc., *i. e.*, until his judgments are all correct.

Explanations of Terms and Diagrams.—When we look at two objects to compare their relative distance, we make our judgment by the difference in their distances from us. In g. 2, A and B represent the two eyes, and O and O′ the two

objects respectively. The two distances may be represented by imaginary lines, one from O and the other from O′ to a point midway between the two eyes, that is, to an imaginary

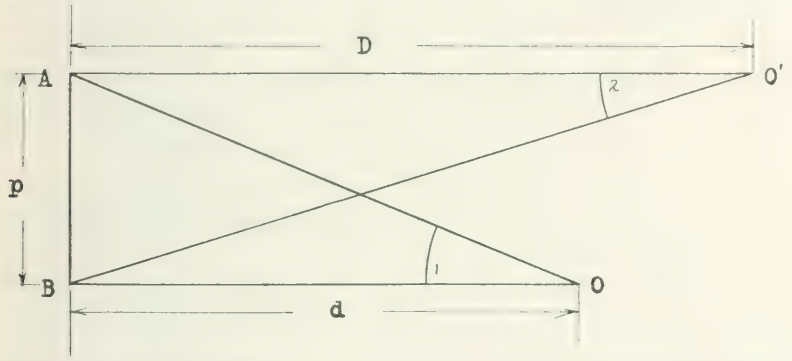

Fig. 2.—True representation of two objects O and O′ at unequal distances from the eyes A and B.

p = interpupillary distance, A B.
d = distance to near object.
D = distance to far object.
D–d = difference in distance or the depth difference.
Angle 1–Angle 2 = angle of the binocular parallax.

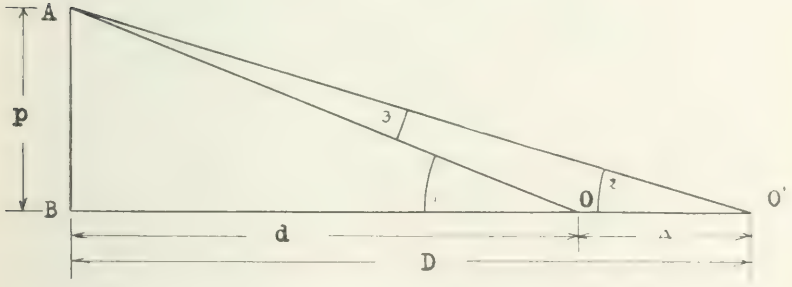

Fig. 3.—Diagrammatic representation of Fig. 2.

D–d = Δ, the depth difference.
Angle 1–angle 2 = angle 3, the binocular parallactic angle.

Cyclopean eye. These distances may be compared with less difficulty by using a more diagrammatic drawing. Let us, therefore, consider one eye B and the two objects O and O′ in a straight line as in Fig. 3. In this figure let—

p = AB, the interpupillary distance; d = BO, the shorter distance; D = BO′, the longer distance; D–d = Δ, the difference in distance or, as it is termed in this paper, the *depth difference.*

Also let ∠1 = ∠AOB, the angle of convergence upon the near object;

and ∠2 = ∠AO′B, the angle of convergence upon the far object;

and ∠3 = ∠OAO′

Then ∠1 – ∠2 = ∠3, which is the binocular parallactic angle represented by the depth difference D–d or Δ.

For small angles, like angles 1, 2 and 3, the sine, the tangent, and the angle in radians may be considered equal with negligible error.

Let r = angle 3 in radians.

then tan of angle $1 = \frac{p}{d}$, and tan of angle $2 = \frac{p}{d}$

and $r = \frac{p}{d} - \frac{p}{D} = \frac{pD-d}{Dd}$

But when p = 0.063 meter, and d and D are 6.000 and 6.005 meters respectively, then by substitution

$r = .063 \frac{.005}{6.000 \times 6.005} = 0.00000874$, which represents the binocular parallactic angle in radians.

In order to convert radians to degrees of arc we must multiply radians by $\frac{180}{\pi}$ and then this result in degrees by 3600 to obtain the final result in seconds of arc.

Therefore 0.00000874 radian = 1.803″.

This angle of 1.803″ is the binocular parallactic angle when the interpupillary distance is 63 mm., the depth difference 5 mm., and the distance of the nearer object 6 meters.

On the basis of this formula the binocular parallactic angles were worked out for interpupillary distances ranging

from 57 to 72.5 mm., and for depth differences ranging at regular intervals from 5 to 360 mm. (See Table I.)

Results of the Test.—One hundred and six subjects or observers, 75 of whom were aviators, were examined with the apparatus. Prior to the test other visual data were recorded, such as age, army service, hours of flying, if any, vision, muscle balance, near-points of convergence and accommodation, and interpupillary distance.

The classification of a subject is not made on the basis of the shortest depth difference at which he gives 20 consecutive correct judgments, but rather upon the shortest depth difference at which he is still at or within his threshold, *i. e.*, when at a certain station the subject makes 15 correct and 5 wrong judgments, the calculation may be made as follows: The 5 wrong judgments may be classified as guesses. To offset these 5 correct judgments should be eliminated also as guesses. That leaves 10 correct judgments which represent the number which the subject actually distinguishes, *i. e.*, just 50 per cent. of the total number of 20. I have accepted, therefore, as the threshold of any individual, that least depth difference at which his judgments are correct not less than 75 per cent. of the time.

The ability of the 106 observers varied greatly. It was found convenient to classify them into 12 groups, based upon their depth-difference thresholds. This classification, with all correlating data, has been recorded in Tables II to VII.

It was found that 14 men had judgment of distance to a remarkable degree. According to a formula expressed above, their respective binocular parallactic angles depend not only upon their depth-difference threshold, but also upon their interpupillary distance. Their depth-difference thresholds were as small as 5 mm. Their interpupillary distances varied from 63 to 72.5 mm. It is obvious that the man having the smallest interpupillary distance would have the smallest binocular parallactic angle. By referring to

Table II we find that the smallest interpupillary distance, 63 mm., represents a binocular parallactic angle of 1.80″. The longest interpupillary distance, 72.5 mm., represents an angle of 2.07″. This difference in angle of 0.27″ denotes an advantage of about 15 per cent. that the man with the longest has over the man with the smallest interpupillary distance, *i. e.*, their actual ability is the same, but the latter observer, with the 63 mm. interpupillary distance, must have a threshold angle of not more than 1.80″ in order to equal the discriminating ability possessed by the 2.07″ angle of the man with the interpupillary distance of 72.5 mm.

The parallactic angle of the remaining 12 observers in Class A ranged between 2.07″ and 1.80″. The average threshold for the entire 14 men was 1.89″.

Class B, Table III, represents a group of 30 men with a threshold of 10 mm. and a binocular parallactic angle averaging 3.67″. Class C, Table IV, represents a group of 15 men with a threshold of 15 mm., and an average angle of 5.5″. Class D, Table V, is a record of a group of 23 men with a threshold of 20 mm., and an average parallactic angle of 7.30″. The remaining eight Classes, E to M, recorded in Tables V–VII, were determined by the depth-difference thresholds, ranging from 30 to 360 mm. These thresholds represent parallactic angles ranging from 10.6″ to 136.2″ (2′ 6.2″).

Discussion of the Binocular Findings.—When we turn our attention to the question of determining the causes for the great difference in the binocular parallax as an individual factor we must refer to the other data, such as visual acuity, muscle balance, etc. The tests which provided this data were carefully made by one examiner and the results obtained checked by another. All visual tests were made under the same condition of surface brightness and illumination. Ocular muscle balance was determined by the screen and parallax tests. The near-point of convergence was taken

from a vertical plane through the anterior foci of the two eyes, but the record was corrected to read from the center of rotation of the eyeballs by adding 25 mm. to the first finding. The interpupillary distance was measured in millimeters by the infinity method, *i. e.*, when the visual axes were parallel.

The results of the tests for the near-point of accommodation, however, are unreliable, because, unfortunately, they were obtained subjectively, and as a consequence many of the findings are absurdly small. When we are reminded that the observers were all endeavoring to make their maximum showing, it is easy to understand why a test for accommodation under such circumstances should not be subjective. Fortunately, the other findings provide sufficient reasons for the individual difference in classification.

In examining the data of Class A we find not only a very high visual acuity, but also, except for two cases, a perfect symmetry of visual acuity. The difference exhibited by the two exceptions is only that between 20/10 and 20/10− for one, and 20/15 and 20/15+ for the other. The average visual acuity of the 14 men was 20/15+ in each eye. The lowest visual acuity was 20/20 O.U., which was found only in one observer. None of the men had ever worn a correction. Tests for muscle balance for distance revealed no hyperphoria. Eight men had orthophoria, and the other six from $\frac{1}{2}$ to 3 prism-diopters of esophoria. There was none with exophoria. The near-point of convergence ranged from 63 to 100 mm., with an average of 83 mm., which is fully normal. The interpupillary distance averaged 66.14 mm., which is over the average. In brief, there were very high visual acuity, practically perfect visual symmetry, and perfect muscle balance. These findings are the more significant after we examine the data of the other classes.

In Class B we find a little less visual acuity, more visual asymmetry, and a few men with corrections; also a number

of observers with small degrees of exophoria and with some hyperphoria; also a few men with a weak convergence for near. The interpupillary distance averaged about 2 mm. less than in Class A.

The other classes, C to M (see Tables IV to VII), show on the whole a steadily decreasing visual acuity and visual symmetry, more subjects wearing corrections and more cases of muscle imbalance.

There was another phenomenon. It was found that some men projected one rod nearer when actually it was the farther. This tendency began to show even in class B, but became quite common in the lower classes. With some it appeared to be connected with a difference in the visual acuity of the two eyes. With others it seemed to be associated with some latent vertical or lateral deviation. Finally it appeared in a few observers to be the sole cause in reducing their power to judge distance. There was no uniformity as to the false projection of either the right or the left rod: one man might persistently project the left rod nearer and another man follow him immediately and strongly project the right rod nearer. It, therefore, cannot be explained by some fault in the method of testing. In fact, there seems to be no adequate explanation of this phenomenon.

Among the less efficient classes there were three or four observers whose poor showing could not be explained on any of the data recorded. One of these, however, was suspected at the time of his test of not giving his conscientious coöperation, and two others admitted at the beginning of the test that they were very tired from lack of sleep.

It seems, therefore, from a study of the data in Tables II to VII, that there are physical reasons for the marked individual variations in the ability of the binocular parallax to judge distance. Furthermore, that it is possible, by means of an apparatus similar to the one used here, to eliminate those candidates whose judgment of distance is below normal

and also to classify the normal observers into several groups according to their degree of excellence.

To determine what should be called a "normal" or "not normal" in the judgment of distance is a very difficult proposition. It is decidedly a relative matter, especially when an examination affords a classification, as this one does. A careful study of the data, however, convinces me that a break occurs between the 20 and 30 mm. depth differences. Beyond the 20 mm. station there seems to be a physical cause for a poor showing in almost every case. With some it was visual asymmetry or some muscle imbalance. With others there was a persistent tendency to project one image nearer. Or it may be that the subject was wearing a high correction. Another thing is noted, *i. e.*, the great majority of the fliers fell into the first four groups. This latter explanation may seem like an empirical one, so I take this opportunity to state, what I should liked to have included in the tables, viz., that I took every opportunity possible to question the fliers upon their training, their accidents, if any, and to obtain their opinions as to the importance of certain visual factors. Therefore basing my conclusions upon all the facts at my disposal, both those recorded and those unrecorded, I feel justified in recommending as normal a binocular parallactic angle not greater than 8.0″ when the test is made with an apparatus made on the principles of the one used in these experiments.

An important feature of the test is the use of the screen or shutter. Lifting this quickly gives a sudden impression of the rods, which is more accurate than is a delayed impression. In fact, most of our every-day depth judgments are made instantaneously or practically so. During the war balloon observers in training were required to make instantaneous judgments of distance in spotting shell-bursts near targets. Of course, in this case linear perspective aided them greatly. An aviator recently told me he was con-

vinced that the success of the great aces was largely due to the fact that they made instant decisions. It would seem then that accurate determination of not only visual but also depth-perception reaction times would be of great value.

This last-mentioned phase of the subject is made the more complex when we reflect that the flier must not only judge his distance accurately, but also his speed. More properly, therefore, the whole subject might with profit be approached from the viewpoint of trying to discover the correlation between judgment of distance and of speed. *A priori* it would seem that those fliers possessing very quick reaction times, as well as small binocular parallactic angle thresholds, should be able to give the best performances.

ACCESSORY DATA.—A. *Monocular Judgment of Distance.*—Our ability to judge distance with one eye only depends upon two things:

1. Terrestrial association. 2. Size of the retinal image, but only when we recognize the object fixated or its association with some other object we know from experience.

In order to be able either to confirm or to refute the opinion expressed by some that the loss of an eye by an aviator should not necessarily disqualify him from further flying, I examined ten men for the purpose of learning their ability to judge distance monocularly. Nine of these men had already been examined by the binocular test. The tenth man was an aviator who had lost one eye through an accident. The results of these tests are recorded in Table X. The same apparatus was used for both the binocular and monocular tests, so the results are comparable. In the former test it was accepted, tentatively at least, that not more than two factors, the binocular parallax and the retinal image, operated in the depth-difference determinations, whereas in the monocular test the difference in size of the retinal images or visual angles of the two rods was the only determining factor. From the data of Table X it is noted

that the average depth difference representing the first recognition of an inequality of the two rods was 250 mm. According to computation derived from Table VIII, this distance represents a difference in visual angle of 0.23′ or 13.8″. The average monocular threshold depth difference, however, is somewhat larger. From the same table we find it to be at least 285 mm., which represents a visual-angle difference threshold of 0.26′ or 15.5″. By referring to the records showing the binocular ability of the nine men we find that their average binocular threshold was represented by a depth difference of only 14.4 mm., or by a binocular parallactic angle of 5.3″. This is about one-third the size of the visual angle required for the monocular test. If, however, we compare the depth-difference thresholds, we find that the binocular ability is twenty times that of the monocular. In other words, according to this conventional test, the binocular parallactic ability is twenty times more valuable as a determining factor in the judgment of distance than the best discrimination recognizable by the retinal image.

From the results obtained by the binocular and monocular tests it is evident that the apparatus, although devised to eliminate all factors except the binocular parallax and the visual angle, actually eliminates everything except the binocular parallax when the test is made with both eyes.

Another important distinction was revealed by the test, and that is, judgment with monocular observation is very slow. One must carefully study the object and surrounding data, while binocular judgment is practically instantaneous.

Monocular vision is also very liable to a "reversal" deception, *e. g.*, a valley may appear in perspective as a hill, or vice versa. In case of a wrong interpretation by a one-eyed aviator trying to land, his disillusionment might easily come too late. On the other hand, binocular single vision may be deceived only when the depth difference is less than

that which subtends the individual's least binocular parallactic angle. What would at first thought appear to be an exception in the case of binocular vision, and which renders it almost as helpless as monocular, occurs when the distance to an absolutely flat surface with no associated objects within the visual field is to be judged, like the distance from an aëroplane to the surface of a perfectly calm sea. In this instance, however, the problem is reduced purely to the judgment of absolute distance, with no relative distance criteria to assist. In other words, there is no depth difference to be judged when there is apparently only one distance.

B. *Judgment of Relative and Absolute Distance.*—Some one may offer the criticism that with this apparatus the applicant is asked to perform a test for judgment of relative distance when the aviator's chief problem is absolute distance. The answer to this is that correct judgment of the latter depends upon the summation of a series or succession of judgments for relative distance, *i. e.*, our eyes instinctively and unconsciously travel back and forth from one associated object to another over the interval to be judged, perhaps not only once, but several times, before our judgment of absolute difference is made. The best example to prove this is the great error made by untrained observers in judging distance on the water.

C. *Night Landings.*—A difficulty similar to landing upon a calm sea arises in making night landings. There is a lack in the necessary visual- and depth-difference contrasts. The Navy Department recognized this difficulty, and several months ago devised an instrument to overcome it. According to a statement in *Aërial Age Weekly* of February 24, 1919, "The naval night altitude indicator consists of four spot-lights whose rays are projected downward from the fuselage at such an angle that when the altitude of fifty feet is reached, the two right and two left beams meet, forming a single spot on the ground. As the plane drops

to a still lower altitude the beams again diverge, thus indicating the approximate distance from the ground. With a little practice the aviator is enabled to make very accurate landings with the assistance of this device."

D. *The Projection of Objects Horizontally Superimposed.* - A test was made on several men to determine their ability to judge which of the two rods was nearer when the apparatus was turned over on its side, thereby putting the rods in a horizontal position. In doing this the advantage of the binocular parallax was entirely lost, and, as was to be expected, the judgment of the relative position of the horizontal rods was no better with two eyes than with one, and was reduced solely to the one factor, viz., the size of the retinal images. A recent aëroplane accident serves as a practical illustration of this inability to judge horizontal objects, especially when they are suspended in the air with no linear parallax and other terrestrial association factors to help. During the Fifth Liberty Loan campaign an aviator was flying a captured Fokker as a member of the United States flying circus. He attempted to make a landing in a field in Cincinnati. His approach was at right angles to and over two sets of telegraph and telephone wires. He flew close to the ground, intending to zoom over the wires and then drop down into the field. What actually happened was that he tore down both sets of wires, broke down a large pole, and crashed. If the flier had realized the difficulty of accurately projecting or judging the distance of horizontal wires with only the sky as a background, he probably would not have attempted the feat.

CONCLUSIONS.

1. Of all the personal factors which aid us in the judgment of distance, the binocular parallax is the most important. By experiment it was found to possess twenty times the ability of the retinal image or visual angle, which

is the important factor in monocular judgment. This, however, should not represent the comparative depth judgment skill of two- and one-eyed persons, because in actual life the extraneous factors, by helping both equally, serve greatly to lessen the difference in ability of the respective personal factors.

2. The minimal binocular parallactic angle varies greatly with individuals. It depends upon such factors as visual acuity, equality of visual acuity, or visual balance, muscle balance, interpupillary distance, and probably some innate and acquired ability.

3. Fourteen observers (12 of whom were pilots), out of 106 examined, were found to possess judgment of distance to a remarkable degree. Their binocular parallactic angles ranged from 1.8″ to 2.0″, with an average of 1.89″.

4. To possess normal judgment of distance one's binocular parallactic angle should not be greater than 8.0″ when the test is performed with an apparatus made on the principles of the one used for these experiments. This includes classes A, B, C, and D of this experiment. (See Tables II–V.)

5. An apparatus like the one used in this experiment is free from the criticism of the hand stereoscope. Furthermore, it permits of classification of individuals according to their discriminating ability. In view of the different requirements in various forms of military aviation it would be an advantage to be able to assign successful applicants to special training according to their different degrees of ability.

6. The value of such an apparatus is greatly enhanced, and much smaller discriminations are possible, by giving the observer a sudden impression of the objects to be judged. Otherwise there is apt to be a disconcerting fluctuation of those objects. Most of our natural binocular judgments are more or less instantaneous. Therefore the shutter on the apparatus is an important requirement.

7. The binocular parallax operates in the judgment of objects maintaining some horizontal or lateral separation, but not for superimposed objects like telegraph wires. In the latter instance judgment is dependent upon the interpretation of the retinal images when all factors extraneous to the individual, like terrestrial association and aërial perspective, are excluded.

8. To estimate correctly the position of an object one must know its direction and distance. Direction is judged more accurately with one eye, but distance better with both. To be denied the privilege of using either one or two eyes at will would be a distinct disadvantage to an aviator.

9. The reaction time required to make monocular judgments of distances is very slow, whereas binocular judgments are practically instantaneous.

10. A tendency to project one image nearer than the other was found in 23 out of the 106 subjects. Some showed this tendency to a marked degree. Although some of these cases had muscle imbalance, others visual asymmetry, and still others had both these abnormal conditions, the phenomenon cannot be explained satisfactorily.

11. The wide variations in the visual angle and binocular parallactic angle thresholds, according to the experiments herein recorded, make it evident that the two angles have nothing to do with each other. It is a mistake, therefore, to assume, because the cones in one's retina are limited to a certain distance apart, that one's binocular parallactic angle must necessarily be limited to the size of the visual angle representing that distance.

12. The effect of low oxygen on the depth-perceiving sense is of little importance, because, at the critical time during the flight, which is the landing, there is no lack of oxygen.

TABLE I.—BINOCULAR PARALLAX IN TERMS OF SECONDS OF ARC.

Inter P.D in mm.	Depth Differences in Millimeters When the Nearer Distance is 6000 mm.; *e. g.*, 5 mm. Represents the Second Object at 6005 Mm.																				
	5	10	15	20	25	30	35	40	50	60	90	120	150	180	210	240	270	300	330	360
57.0	1.628″	3.255″	4.880″	6.505″	8.128″	9.737″	11.349″	13.005″	16.178″	19.389″	28.945″	38.405″	47.773″	57.054″	66.242″	75 343″	84.357″	93.286″	102.131″	110.893″
57.5	1.645	3.289	4.931	6.572	8.205	9.833	11.462	13.089	16.339	19.569	29.210	38.755	48.210	57.572	66.839	76.024	85.115	94.120	103.041	111 878
58.0	1.662	3.322	4.975	6.624	8.273	9.919	11.563	13.208	16.478	19.739	29.463	39.091	48.627	58.069	67.420	76.682	85.855	94 942	103.943	112.855
58.5	1.676	3.343	5.010	6.676	8.311	10.004	11.663	13 314	16.615	19.909	29.717	39.427	49.044	58.567	67.998	77.338	86.589	95.752	104 829	113.822
59.0	1 687	3.372	5.056	6.738	8.419	10.090	11.760	13.429	16.762	20.080	29.972	39.766	49.466	59.072	68.585	78.006	87.335	96.576	105.723	114 795
59.5	1.703	3.405	5.105	6.798	8.487	10.175	11.862	13.546	16.905	20.249	30.225	40.102	49.884	59.570	69.163	78.664	88.074	97.395	106.628	115.775
60.0	1.720	3.435	5.143	6.850	8.557	10.261	11.954	13.660	17.080	20.420	30.480	40.440	50.304	60.071	69.744	79.324	88.812	98.210	107 519	116.741
60.5	1.728	3.455	5.181	6.905	8.623	10.350	12.058	13.767	17.183	20.589	30.764	40.775	50.763	60.575	70.325	79.986	89.553	99.029	108.514	117.712
61.0	1.745	3.488	5.230	6.971	8.702	10.431	12.160	13.886	17.333	20.759	30.987	41.113	51.141	61.076	70.906	80.646	90.293	99.848	109 313	118 735
61.5	1.767	3.527	5.276	7.029	8.777	10.528	12.266	14.010	17.477	20.936	31.246	41.457	51.567	61.579	71 494	81.312	91.039	100.672	110.214	119 757
62.0	1.776	3.545	5.312	7.077	8.842	10.604	12.361	14.112	17.610	21.103	31.498	41.789	51.981	62.075	72.075	81.970	91.775	101.487	111.107	120 635
62.5	1.786	3.571	5.354	7.137	8.916	10.686	12.456	14 224	17.751	21.268	31.746	42.121	52.396	62.570	72.646	82.626	92.514	102.299	111.992	121.603
63.0	1.803	3.605	5.405	7.197	8.986	10.774	12.560	14.344	17.899	21.441	32.003	42.462	52.819	63.075	73.232	83.291	93.254	103.122	112.897	122.579
63.5	1.819	3.635	5.448	7.250	9.056	10.860	12.663	14.457	18.038	21.564	32.241	42.754	53.192	63.529	73.766	83 905	93.946	103.902	113.745	123.505
64.0	1.832	3.658	5 482	7.306	9.119	10.940	12.756	14.565	18.180	21.780	32.509	43.133	53.654	64.072	74 390	84.609	94.730	104.754	114.684	124.520
64.5	1.844	3.688	5.530	7.370	9.200	11.029	12.857	14.682	18 325	21.949	32.763	43.471	54.074	64.576	74.974	85 275	95.473	105.577	115.581	125.497
65.0	1.861	3.721	5.574	7.423	9.270	11.116	12.960	14.800	18.465	22.122	33.021	43 813	54.499	65.080	75.558	85.936	96.214	106.395	116.480	126.470
65.5	1.877	3.746	5.612	7.478	9.342	11.204	13.058	14.909	18.606	22.294	33.273	44.145	54.912	65.574	76.134	86.592	96.951	107.210	117.373	127.439
66.0	1.886	3.771	5.654	7.536	9.414	11.284	13.154	15.021	18.751	22.458	33.523	44.479	55.330	66.074	76.716	87 254	97.692	108.029	118.272	128 415
66.5	1.902	3 804	5.704	7.595	9.484	11.371	13.257	15.140	18 891	22.631	33.781	44.822	55.756	66.581	77.300	87.917	98.433	108.848	119 166	129.386
67.0	1.919	3.835	5.743	7.650	9.556	11.459	13.361	15.252	19.032	22.805	34.038	45.157	56.171	67.077	77.879	88.576	99.172	109.666	120.062	130.359
67.5	1.930	3 857	5.781	7.705	9.627	11.542	13.452	15.361	19.174	22.969	34.284	45.488	56.586	67.575	78.458	89.237	99.912	110.486	120.958	131.331
68.0	1.944	3.888	5.829	7.769	9.699	11.627	13.554	15.479	19.318	23.140	34.541	45.826	57.011	68.076	79.042	89.899	100.651	111.302	121.852	132.302
68.5	1.962	3.922	5.875	7.824	9.771	11.715	13.659	15.597	19.460	23.315	34.802	46.150	57.429	68.580	79.623	90.560	101.393	112 123	122.752	133.280
69.0	1.978	3.946	5.913	7.878	9.841	11.802	13.755	15.705	19.595	23 483	35.049	46.502	57.845	69.079	80.199	91.219	102.135	112.941	123.646	134.249
69.5	1 987	3.972	5.955	7.936	9.913	11.883	13.851	15.818	19.714	23.649	35.301	46.833	58.267	69.582	80.784	91.879	102.869	113.755	124.538	135.219
70.0	2.003	4.005	6.004	7.995	9.984	11.970	13.955	15.938	19.885	23.823	35 561	47.180	58.686	70.081	81.365	92.542	103.612	114.578	125.440	136 200
70.5	2.019	4.035	6.043	8 055	10.055	12.058	14.057	16.048	20.027	23.996	35.812	47.513	59.103	70.581	81.948	93.207	104.355	115.395	126.333	137.167
71.0	2.031	4.057	6 082	8.105	10.126	12.140	14.150	16.158	20.169	24.144	36.062	47.848	59.525	71.082	82.526	93.861	105.088	116.209	127.225	138.137
71.5	2.044	4.087	6.128	8.167	10.197	12.225	14.251	16.276	20.310	24.331	36.320	48.190	59.942	71.580	83.106	94.523	105.831	117.032	128.127	139.113
72.0	2.062	4.121	6.175	8.223	10.269	12.314	14.357	16.392	20.453	24.502	36.577	48.525	60.362	72.083	83.693	95.191	106.574	117.850	129.020	140.085
72.5	2.077	4.146	6.212	8.277	10.340	12.401	14.452	16.501	20.595	24.673	36.826	48.860	60.781	72.586	84.271	95.845	107.309	118.665	129.904	141.058

Note.—Each increase of 1 mm. in interpupillary distance gives an advantage of about 1.6 per cent.; *i. e.*, the man with the 72.5 p.d. has an advantage of 15 per cent. over the man with the 63 mm. p.d.

TABLE II.—CLASSIFICATION OF OBSERVERS ACCORDING TO THEIR BINOCULAR PARALLACTIC ANGLE.

CLASS A. THOSE WHOSE THRESHOLD IS REPRESENTED BY A DEPTH DIFFERENCE OF 5 MM.

No.	Name	Age	Army Service	Hours Flying	Vision	Muscle Balance	N.P. Accom.	N.P. Conv.	Inter P.D.	Correct Judgments in 20 Trials						
										Depth Differences					Per Cent. Correct at 5 Mm.	Binocular Parallactic Angle
										30 Mm.	20 Mm.	15 Mm.	10 Mm.	5 Mm.		
1	W. O'T.	19	Chauffeur Med. Dept.		R. 20 10 L. 20 10	Orth.	85	65	63	20	20	20	20	15	75	1.803″
2	C. B. W.	26	Aerial Observer	180	R. 20 15+ L. 20 15+	Eso. 1½	120	63	63.5	20	20	20	20	16	80	1.819″
3	O. A. B.	41	Med. Corps		R. 20 15 L. 20 15	Orth.	150	70	63.5	20	20	20	18	16	80	1.819″
4	T. L. O.	25	Pilot	150	R. 20 10 L. 20 10−	Eso. ½	115	80	63.5	20	20	20	20	15	75	1.819″
5	S. A. P.	28	Pilot	65	R. 20 15− L. 20 15−	Orth.	120	95	64	20	20	20	18	16	80	1.832″
6	A. H.	21	Pilot	60	R. 20 15 L. 20 15	Eso. ½	100	95	66	20	19	18	18	17	85	1.886″
7	S. V. T.	26	Pilot	100	R. 20 15+ L. 20 15+	Orth.	110	95	66	20	20	19	18	16	80	1.886″
8	D. R. S.	26	Pilot	300	R. 20 15 L. 20 15	Orth.	R. 115 L. 105	65	66	20	19	18	18	15	75	1.886″
9	W. R. D.	27	Pilot	500	R. 20 20 L. 20 20	Eso. ½	90	90	66	20	20	19	20	15	75	1.886″
10	J. N. L.	25	Pilot	150	R. 20 10− L. 20 10−	Orth.	105	93	67	20	20	20	18	18	90	1.919″
11	R. W. E.	23	Pilot	140	R. 20 10− L. 20 10−	Orth.	97	75	67	20	19	19	19	16	80	1.919
12	W. A. B.	22	Pilot	200	R. 20 15 L. 20 15+	Eso. 3	65	100	69	20	20	20	16	18	90	1.978″
13	L. B. C.	21	Pilot	150	R. 20 15+ L. 20 15−	Orth.	95	100	69	20	20	20	19	17	85	1.978″
14	O. G. H.	21	Pilot	400	R. 20 20 L. 20 20	Eso. 1½	95	75	72.5	20	20	20	17	15	75	2.077″
AVERAGE		25			O. U. 20 15+	Eso. ½	106	83	66						80	1.893″

TABLE III.—CLASSIFICATION OF OBSERVERS—(*Continued.*)

CLASS B. THOSE WHOSE THRESHOLD IS REPRESENTED BY A DEPTH DIFFERENCE OF 10 MM.

No.	Name	Age	Army Service	Hours Flying	Vision	Muscle Balance	N.P. Accom.	N.P. Conv.	Inter P.D.	Image Projected Nearer	Correct Judgments in 20 Trials							Remarks
											Depth Differences					Per Cent. Correct at 10 Mm.	Binocular Parallactic Angle	
											30 Mm.	20 Mm.	15 Mm.	10 Mm.	5 Mm.			
15	C.B.	13	School boy	..	R.20 15+ L.20 15+	Eso. 1	90	60	57	.	20	20	17	16	11	80	3.255″	
16	J.N.B.	44	Med. Corps	..	R.20 15 L.20 15	Orth.	375	80	59.5		20	20	17	18	8	90	3.405″	
17	Thom.	33	Pilot	250	R.20 15 L.20 15	Orth.	150	90	60	..	19	16	15	15	12	75	3.435″	
18	L.P.K.	29	Pilot	250	R.20 15− L.20 15−	Eso. 1	90	105	61	Left	20	17	15	16	9	80	3.488″	Tendency to project left rod nearer when the two rods are in same plane.
19	H.L.L.	31	Pilot	175	R.20 10− L.20 10	Orth.	75	96	62	..	20	20	20	17	8	85	3.545″	
20	D.L.J.	23	Pilot	50	R.20 20 L.20 20	Orth.	85	75	62	..	20	18	18	15	10	75	3.545″	
21	A.R.T.	23	Pilot	75	R.20 10 L.20 10	Orth.	115	90	62.5	..	20	20	19	19	10	95	3.571″	
22	L.C.A.	22	Pilot	50	R.20 15 L.20 15	Exo. 1	80	75	62.5	..	20	17	19	18	12	90	3.571″	
23	H.H.	24	Pilot	80	R.20 15− L.20 15−	Eso ½	100	95	63	..	20	20	17	19	11	95	3.605″	
24	G.A.B.	22	Pilot	400	R.20 15 L.20 10	Exo. 1½	73	88	63	..	20	17	17	17	10	85	3.605″	
25	R.W.S.	25	Pilot	200	R.20 15+ L.20 15+	Exo. 1½	95	90	63	.	20	18	19	16	8	80	3.605″	
26	J.C.R.	23	Pilot	500	R.20 15 L.20 15	Orth.	107	85	63	..	20	20	20	17	13	85	3.605″	
27	G.C.F.	22	Pilot	31	R.20 15 L.20 15	Orth.	98	100	63	.	20	20	15	16	14	80	3.605″	
28	H.C.S.	25	Pilot	110	R.20 15− L.20 15−	Exo. ½	105	125	63	..	20	20	20	15	7	75	3.605″	
29	J.T.D.	23	Med. Corps	..	R.20 15+ L.20 15−	Eso. 1	90	75	63.5	..	20	19	18	16	8	80	3.635″	Wearing moderate myopic correction. Vision excellent and practically equal.

30	C.T.F.	23	Pilot	200	R. 20 15 L. 20 15	Eso. ½	R. 130 L. 115	65	64.5	..	20	20	17	18	10	90	3.688″	
31	P.W.C.	45	Med. Corps		R. 20 15 L. 20 15	Exo. ½ L.H. ½	325	100	64.5	..	20	20	18	15	12	75	3.688″	Wearing mixed astigmatic correction. Vision excellent and symmetric.
32	J.H.Mc.	26	Pilot	95	R. 20 15 L. 20 15	Eso. ½	110	95	65	Right	20	20	20	17	8	85	3.721″	Tendency to project right rod nearer when the two rods are in same plane.
33	E.G.	26	Pilot	95	R. 20 20 L. 20 20	L.H. 1	92	82	65	.	20	18	15	16	12	80	3.721″	
34	W.C.S.	26	Pilot	90	R. 20 15 L. 20 15	Orth.	95	85	65.5	.	20	20	17	19	9	95	3.746″	
35	H.Mac.	23	Pilot	100	R. 20 15 L. 20 15	Eso. 2 R.H. ½	120	100	66	.	20	19	18	19	11	95	3.771″	
36	H.C.	27	Pilot	70	R. 20 15 L. 20 15	Orth.	100	70	66	.	20	20	20	15	13	75	3.771″	
37	W.S.R.	24	Pilot	100	R. 20 15 L. 20 15	Orth.	105	85	66.5		20	19	17	16	12	80	3.804″	
38	C.L.P.	23	Pilot	50	R. 20 15 L. 20 15	Orth.	95	110	67	..	20	20	19	16	7	80	3.835″	
39	B.S.	22	Pilot	250	R. 20 15 L. 20 15	Eso. 1	97	85	67	Left	20	20	15	15	8	75	3.835″	Tendency to project left rod nearer when the two rods are in same plane.
40	E.H.	33	Med. Corps		R. 20 20 L. 20 15	Orth.	165	115	67	.	20	20	16	15	9	75	3.835″	
41	J.M.W.	39	Med. Corps		R. 20 15 L. 20 15	Exo. 3	110	60	67	.	18	19	18	15	12	75	3.835″	Wearing myopic correction. Vision excellent and symmetric.
42	A.W.M.	23	Pilot	300	R. 20 15 L. 20 10	Eso. 2	70	85	69	.	20	19	19	17	12	85	3.946″	
43	T.J.V.	24	Pilot	300	R. 20 20 L. 20 10	Exo. ½	75	65	70	.	20	20	16	15	11	75	4.005″	
44	W.K.D.	22	Pilot	185	R. 20 15 L. 20 15	Eso. ½	96	85	71	Right	20	18	17	15	5	75	4.057″	Tendency to project right rod nearer when the two rods are in same plane.
Average		26.2			O.U. 20 15	Orth.	118	87	64.3	.	.	.	.	.	.	82.2	3.678″	

TABLE IV.—CLASSIFICATION OF OBSERVERS—(*Continued.*)

CLASS C—THOSE WHOSE THRESHOLD IS REPRESENTED BY A DEPTH DIFFERENCE OF 15 MM

No.	Name	Age	Army Service	Hours Flying	Vision	Muscle Balance	N.P. Accom.	N.P. Conv.	Inter P.D.	Image Projected Nearer	Correct Judgments in 20 Trials							Remarks
											Depth Differences					Per Cent Correct at 15 Mm.	Binocular Parallactic Angle	
											40 Mm.	30 Mm.	20 Mm.	15 Mm.	10 Mm.			
45	H.J.H.	39	Med. Corps	..	R.20 10 − L.20 10 −	Eso. ½	145	70	59		20	20	20	15	10	75	5.056″	Wearing high correction for compound hyperopic astigmatism.
46	J.D.C.	23	Pilot	125	R.20 15 L.20 15	Orth.	142	100	60	.	20	16	19	15	11	75	5.143″	
47	P.A.W.	26	Pilot	15	R.20 15 L.20 20	Orth.	102	92	61	Right	20	18	16	16	12	80	5.230″	Projects right rod nearer. Vision better in right eye.
48	E.B.G.	38	Med. Corps	..	R.20 15 + L.20 15 +	Eso. 2	145	60	62.5	.	20	20	20	16	14	80	5.354″	Wearing high mixed astigmatic correction.
49	E.L.H.	24	Pilot	200	R.20 15 + L.20 10	Exo. 1	R. 110 L.102	100	64	Left	20	17	18	16	13	80	5.482″	Projects left rod nearer. Vision better in left eye.
50	H.M.J.	34	San. Corps	..	R.20 15 L.20 15	Orth.	150	95	64.5	..	20	20	17	16	11	80	5.530″	See note below.
51	L.H.B.	34	Med. Corps	..	R.20 15 − L.20 15 +	R.H. ½	150	108	64.5	..	20	20	20	15	13	75	5.530″	Convergence power below normal.
52	C.K.	23	Med. Corps	..	R.20 15 L.20 15	Exo. 1½	R. 90° L.100	85	65	..	20	20	18	18	9	90	5.574″	Wearing correction for compound myopic astigmatism.
53	E.L.S.	22	Pilot	100	R.20 15 L.20 15	Eso. 1	95	85	66	..	20	20	18	17	13	85	5.654″	
54	W.G.B.	23	Pilot	100	R.20 15 L.20 15	Eso. ½	90	100	66	..	20	20	20	16	11	80	5.654″	
55	E.A.B.	28	Pilot	200	R.20 15 − L.20 15	Eso. ½	110	90	66	Left	20	20	20	15	13	75	5.654″	Projects left rod nearer.
56	E.W.K.	27	San. Corps	..	R.20 15 L.20 15 +	Exo. 1 Exo. 12	130	90	66	..	20	20	19	15	13	75	5.654″	Excessive exophoria for near.
57	W.S.P.	26	Pilot	150	R.20 15 + L.20 15 +	Eso. 1	115	95	67	..	20	20	19	16	9	80	5.743″	
58	R.W.P.	23	Pilot	200	R.20 15 L.20 15	Eso. ½	120	130	68	..	20	19	19	16	11	80	5.829″	Has weak convergence.
59	H.W.R.	24	Pilot	150	R.20 30 L.20 30	Eso. ½	70	65	70	..	20	15	16	16	10	80	6.004″	Thinks his low vision due to excessive smoking.
Average.....		27.1	..	..	R.20 15 L.20 15	Eso. ½	118	91	65.6	..	..	..	..	..	..	79.3	5.540″	

NOTE.—Case No. 50 was the first subject experimented upon. The next day the effect of the shutter was discovered. A subsequent test of this man, who was a most careful observer, put him in Class A when shutter was used.

TABLE V.—CLASSIFICATION OF OBSERVERS—*(Continued.)*

CLASS D.—THOSE WHOSE THRESHOLD IS REPRESENTED BY A DEPTH DIFFERENCE OF 20 MM.

No.	Name	Age	Army Service	Hours Flying	Vision	Muscle Balance	N.P. Accom.	N.P. Conv	Inter P.D.	Image Projected Nearer	Correct Judgments in 20 Trials							Remarks
											Depth Differences					Per Cent. Correct at 20 Mm.	Binocular Paralactic Angle	
											40 Mm.	30 Mm.	20 Mm.	15 Mm.	10 Mm.			
60	E B.	12	School boy	..	R 20 15 L 20 15 −	Eso. ½	82	75	58.5	..	20	20	19	13	11	95	6.676″	
61	H A G	26	Pilot	300	R 20 15 L 20 15	Exo. 2 Exo. 9	108	95	59.5	.	20	19	20	13	7	100	6.798″	Excessive exophoria both for near and distance
62	N S A	24	Pilot	300	R 20 15 L 20 15	Orth.	100	60	60		20	20	17	11	8	85	6 850″	
63	R K H	23	Pilot	.	R 20 15+ L 20 15+	Orth.	100	85	60	..	20	19	15	9	9	75	6 850″	
64	C P M	22	Pilot	175	R 20 15 L 20 15	Orth.	95	70	61	..	20	18	15	10	13	75	6 971″	
65	R J H	24	Pilot	200	R 20 15 L 20 15	Exo. 1½ Exo. 10	100	155	62	Left	20	20	18	7	11	90	7 077″	Projects left rod nearer. Has very weak convergence
66	N B L	26	Observer	60	R 20 15 L 20 15	Exo. ½	127	88	62	Left	20	20	16	12	11	80	7 077″	Projects left rod nearer
67	C B T	31	Pilot	150	R 20 20+ L 20 20	Eso. ½	102	85	63	..	20	17	15	12	13	75	7 197″	
68	G A Y.	32	Pilot	.	R 20 15 L 20 15	Eso. 1	120	75	63	Right	20	17	15	11	12	75	7 197″	Projects right rod nearer
69	H R C	26	Pilot	100	R 20 20 − L 20 20 −	Eso. 1	85	90	63.5	.	19	16	16	13	12	80	7 250″	
70	E B M	22	Pilot	60	R 20 15 L 20 15 +	Exo. 1 Exo. 12	100	175	64	.	20	18	16	7	8	80	7 306″	Excessive exophoria and very weak convergence
71	J L J	30	Pilot	175	R 20 15 − L 20 15 −	Orth.	115	85	65	Left	20	20	18	5	7	90	7.423″	Projects left rod nearer.
72	W H P	24	Pilot	400	R 20 15 − L 20 15	Eso. ½	85	90	65	.	20	18	18	13	11	90	7 423″	
73	G B B	25	Pilot	165	R 20 15 − L 20 15 −	Eso. 1½ R.H.1	95	60	65	Left	20	20	16	8	13	80	7 423″	Tendency to project left rod nearer. Has a latent vertical deviation
74	H S S.	22	Pilot	60	R 20 15 L 20 15	Eso. 5	95	92	65	..	20	20	16	6	8	80	7 423″	Excessive exophoria for distance

TABLE V.—CLASSIFICATION OF OBSERVERS—CLASS D—(*Continued.*)

No.	Name	Age	Army Service	Hours Flying	Vision	Muscle Balance	N.P. Accom.	N.P. Conv.	Inter P.D.	Image Projected Nearer	Correct Judgments in 20 Trials							Remarks
											Depth Differences					Per Cent. Correct at 20 Mm.	Binocular Parallactic Angle	
											40 Mm.	30 Mm.	20 Mm.	15 Mm.	10 Mm.			
75	M.A.M.	31	Pilot	250	R.20 20 — L.20 30	Exo. 2	110	80	65	Right	20	20	15	8	11	75	7.423″	Projects right rod nearer. Vision not normal and not symmetric.
76	C.M.S.	23	Pilot	80	R.20 15 — L.20 15	Orth.	115	90	65	Left	20	19	15	8	6	75	7.423″	Projects left rod nearer.
77	J.J.V.	24	Pilot	200	R.20 15 — L.20 15 —	Orth.	85	80	66.5	..	20	20	15	12	7	75	7.595″	
78	H.M.H.	24	Pilot	160	R.20 10 — L.20 10 —	Eso. ½	98	60	67	Left	20	18	17	16	13	85	7.650″	Projects left rod nearer.
79	J.H.V.	29	Balloon Observer	150	R.20 15 L.20 15	Eso. ½	110	50	57	..	20	20	16	11	12	80	7.650″	No sleep the previous night. Gave conscientious assistance in test but stated he was too tired to do well.
80	B.L.W.	56	Med. Corps	..	R.20 15 + L.20 15 +	Eso. 4	310	75	67	..	20	15	16	10	9	80	7.650″	Wearing hyperopic and presbyopic corrections. Accommodation taken without near correction.
81	D.C.M.	25	Pilot	..	R.20 15 L.20 15	Eso. 1	75	50	67	..	20	19	15	14	10	75	7.650″	
82	R.E.	24	Pilot	125	R.20 15 L.20 15 —	Eso. 3 Eso. '10	65	60	71	..	15	16	16	14	8	80	8.105″	Has had marked asthenopic symptoms recently. Examination showed mixed astigmatism.
AVERAGE.....		26.3	..	..	O.U.20 15 —	Eso. ⅜	108	83	64	..	.	..	..	..	..	81.5	7.308″	

NOTE.—Phoria for near has only been recorded when abnormal. Near findings are designated by the prime sign, e. g., Exo.′ 12.

TABLE VI.—CLASSIFICATION OF OBSERVERS—(*Continued.*)

CLASS E.—THOSE WHOSE THRESHOLD IS REPRESENTED BY A DEPTH DIFFERENCE OF 30 MM.

No.	Name	Age	Army Service	Hours Flying	Vision	Muscle Balance	N.P. Accom.	N.P. Conv.	Inter P.D.	Image Projected Nearer	Correct Judgments in 20 Trials							Remarks
											Depth Differences					Per Cent. Correct at 30 Mm.	Binocular Parallactic Angle	
											50 Mm.	40 Mm.	30 Mm.	20 Mm.	15 Mm.			
83	W.W.M.	26	Pilot	.	R.20 20 — L.20 15	Orth.	84	65	62	Right	16	15	15	10	..	75	10.604″	Projects right rod nearer. Very erratic, easily fatigued. Lossofsleep for several nights.
84	C.T.	26	Pilot	170	R 20 15 + L.20 15 +	Orth.	120	65	62.5	Left	20	18	15	6	..	75	10.686″	Strong tendency to project left rod nearer.
85	C.P.H.	31	Pilot	..	R 20 15 — L 20 15 —	Exo. 5 L.H. 3	190	90	63	..	..	20	19	13	11	95	10.774″	Has muscle imbalance.
86	E.W.D.	41	Med. Corps	..	R 20 15 L.20 15	Eso. 2	105	80	64	..	.	20	16	11	12	80	10.940″	Wearing high hyperopic correction.
87	J.H.	28	Med. Corps	.	R.20 15 L. 20 15	Exo. 1	135	67	64.5	.	..	20	17	11	8	85	11.029″	Wearing high hyperopic correction.
88	E.C.	47	San. Corps	..	R 20 20 — L.20 20 +	Exo 1 L.H 1	R.170 L.160	90	64.5	..	18	19	16	12	8	80	11.029″	Wearing myopic correction. Has latent vertical deviation.
89	P.D.	13	Med. Corps	..	R 20 10 L.20 10	Exo 2	185	55	65.5	..	.	20	16	12	10	80	11.204″	Wearing astigmatic correction.
90	J.D.G.	37	Med. Corps	.	R.20 15 — L 20 15 —	Exo 2 R.H. 1	155	115	67	..	..	20	18	13	13	90	11.459″	Has weak convergence.
91	J.D.B.	29	Med. Corps	..	R 20 10 — L.20 10 —	Orth.	110	90	67	Right	.	20	16	7	..	80	11.459″	Projects right image nearer. Wearing high correction for hyperopic astigmatism.
92	J.R.C.	21	Pilot	100	R 20 20 + L.20 20 —	Eso. 1	90	80	69	Left	..	20	17	12	7	85	11.802″	Strong tendency to project left rod nearer.
AVERAGE		32.9			R.20 15 — L.20 15	Exo. 1	134	80	65	.	..	..	..	..	..	82.5	11.099″	

TABLE VI. CLASSIFICATION OF OBSERVERS.—(*Continued.*)

CLASS F.—THOSE WHOSE THRESHOLD IS REPRESENTED BY A DEPTH DIFFERENCE OF 40 MM.

No.	NAME	AGE	ARMY SERVICE	HOURS FLYING	VISION	MUSCLE BALANCE	N.P. ACCOM.	N.P. CONV.	INTER P.D.	IMAGE PROJECTED NEARER	CORRECT JUDGMENTS IN 20 TRIALS							REMARKS
											Depth Differences					Per Cent. Correct at ~~300~~ Mm.	Binocular Paralactic Angle	
											50 Mm.	40 Mm.	30 Mm.	20 Mm.	15 Mm.			
93	C.J.R.	52	San. Corps		R.20 40+ L.20 30	Exo. 1	190	100	65		20	18	12	14	11	90	14.800″	Wearing correction but vision not normal and not symmetric.
94	G.C.P.	30	Pilot	300	R.20 30− L.20 30−	Exo. ½	75	100	66	..	20	16	13	11	..	80	15.021″	Vision not normal but equal in the two eyes. Had no serious landing trouble.
95	L.E.B.	30	Balloon Observer	100	R.20 30 L.20 15	Exo. 1½	R 165 L.192	100	69	Left	20	17	10	.	.	85	15.705″	Projects left rod nearer. Considerable uncorrected hyperopia. Vision better in left eye.
AVERAGE		37	..	..	R.20 30− L.20 20−	Exo. 1	147	100	67	..	..	..	..	..	..	85	15.175″	

TABLE VII.—CLASSIFICATION OF OBSERVERS—(*Continued.*)

CLASS II.—THOSE WHOSE THRESHOLD IS REPRESENTED BY A DEPTH DIFFERENCE OF 60 MM.

No.	Name	Age	Army Service	Hours Flying	Vision	Muscle Balance	N.P. Accom.	N.P. Conv.	Inter P.D.	Image Projected Nearer	Correct Judgments in 20 Trials: Depth Differences 90 Mm.	60 Mm.	50 Mm.	40 Mm.	30 Mm.	Per Cent. Correct at 60 Mm.	Binocular Paralactic Angle	Remarks
96	H.F.H.	24	Pilot	300	R.20 30− L.20 20−	Eso. ½	95	110	62	..	..	20	14	16	8	100	21.103″	Slightly myopic. Vision not symmetric. Has weak convergence.
97	E.W.D.	41	Med. Corps		R.20 30 L.20 30	Eso. 2	105	80	64	.	..	20	11	..		100	21.780″	Same case as No. 86, but with vision uncorrected.
98	P.W.C.	45	Med. Corps	..	R.20 50 . L.20 50+	Exo ½ L. H. ½	325	100	64.5	.	20	16	11	.		80	21.949″	Same case as No. 31, but with vision uncorrected.
99	J.M.W.	39	Med. Corps	..	R.20 50 L.20 50	Exo. 3	140	60	67	..	..	20	.	..	..	100	22.805″	Same case as No. 41, but with vision uncorrected.
AVERAGE . .		37.3		..	R.20 40 L.20 40+	Exo ¼	166	88	64.4	.	..	..	..	..	..	95	21.909″	

CLASS I.—THOSE WHOSE THRESHOLD IS REPRESENTED BY A DEPTH DIFFERENCE OF 90 MM.

No.	Name	Age	Army Service	Hours Flying	Vision	Muscle Balance	N.P. Accom.	N.P. Conv.	Inter P.D.	Image Projected Nearer	Correct Judgments in 20 Trials: Depth Differences 150 Mm.	120 Mm.	90 Mm.	60 Mm.	50 Mm.	Per Cent. Correct at 90 Mm.	Binocular Paralactic Angle	Remarks
100	P.F.O.	28	Pilot	150	R.20 30+ L.20 30+	Eso. ½	100	50	62	Left	20	19	16	14	8	80	31.498″	Very strong tendency to project left rod nearer. Vision not normal but equal
AVERAGE		Same as above																

TABLE VII.—CLASSIFICATION OF OBSERVERS—(*Continued.*)

CLASS J.—THOSE WHOSE THRESHOLD IS REPRESENTED BY A DEPTH DIFFERENCE OF 120 MM.

No.	Name	Age	Army Service	Hours Flying	Vision	Muscle Balance	N.P. Accom.	N.P. Conv.	Inter P.D.	Image Projected Nearer	Correct Judgments in 20 Trials							Remarks
											Depth Differences					Per Cent. Correct at 60 Mm.	Binocular Paralactic Angle	
											90 Mm.	60 Mm.	50 Mm.	40 Mm.	30 Mm.			
101	V.T.S.	30	Med. Corps	..	R.20 70 L.20 200	Eso. 1	145	160	69	..	20	17	14	10	8	85	46.502″	Highly myopic; not corrected.
AVERAGE..... Same as above.																		

CLASS K.—THOSE WHOSE THRESHOLD IS REPRESENTED BY A DEPTH DIFFERENCE OF 180 MM.

											180 Mm.	150 Mm.	120 Mm.	90 Mm.	60 Mm.	Per Cent. Correct at 180 Mm.		
102	J.M.W.	39	Med. Corps	..	R.20 200 L.20 200	Exo. 3	140	60	67	..	18	..	..	..	..	90	67.077″	Same case as Nos. 31 and 98. Left eye alone corrected to make vision symmetric.
103	A.B.H.	26	Pilot	120	R.20 15 – L.20 15 –	Eso. 3	102	70	71	Left	20	14	12	10	13	100	71.082″	Strong tendency to project left rod nearer. Single binocular vision for near, but intermittent for distance.
AVERAGE.....		32.5	..	..	O.U.20 50 –	Orth.	121	65	69	..	..	..	..	..	..	95	69.079″	

CLASS L.—THOSE WHOSE THRESHOLD IS REPRESENTED BY A DEPTH DIFFERENCE OF 270 MM.

											300 Mm.	270 Mm.	240 Mm.	210 Mm.	180 Mm.	Per Cent. Correct at 270 Mm.		
104	W.T.G.	39	A.S. Non Flier	..	R.20 50+ L.20 15	Eso. 4	R.250 L.185	80	64	Right	20	18	12	16	8	90	94.730"	Small central relative scotoma R.E. Strong tendency to project right rod nearer. Vision not symmetric
AVERAGE	Same as above																	

CLASS M.—THOSE WHOSE THRESHOLD IS REPRESENTED BY A DEPTH DIFFERENCE OF 360 MM.

											360 Mm.	240 Mm.	180 Mm.			Per Cent. Correct at 360 Mm.		
105	J.M.W.	39	Med. Corps	..	R.20 200 L.15 200	Eso. 3	140	60	67	..	16	..	..	..	..	80	130.359"	Same case as Nos. 31, 98, and 102, but with vision wholly uncorrected
106	S.E.G.	55	Med. Corps	..	R.20 200 L.20 100	..	..	..	70	..	16	12	10	..	..	80	136.200"	Myopic test made without correction.
AVERAGE	..	42		..	R.20 200 L.20 200—		..	..	68.5	..	..	..	..	..	..	80	133.280"	

TABLE VIII.—VARIATIONS IN THE VISUAL ANGLE SUBTENDED BY A 10 MM. ROD AT DIFFERENT DISTANCES.

Distance in Mm.	Angle in Minutes	Distance in Mm.	Angle in Minutes	Distance in Mm.	Angle in Minutes	Distance in Mm.	Angle in Minutes
6000	5.730	6040	5.691	6150	5.590	6270	5.463
6005	5.725	6050	5.682	6180	5.563	6285	5.470
6010	5.720	6060	5.673	6210	5.536	6300	5.457
6015	5.715	6090	5.645	6240	5.509	6330	5.431
6020	5.710	6120	5.617	6250	5.500	6360	5.405
6030	5.701						

TABLE IX.—SIZE OF OBJECT REQUIRED TO MAINTAIN A VISUAL ANGLE OF 5.73 MINUTES AT THE FOLLOWING DISTANCES.

Distance in Mm.	Size of Object in Mm.	Distance in Mm.	Size of Object in Mm.	Distance in Mm.	Size of Object in Mm.	Distance in Mm	Size of Object in Mm.
6000	10.000	6040	10.067	6150	10.250	6270	10.450
6005	10.008	6050	10.083	6180	10.300	6285	10.475
6010	10.017	6060	10.100	6210	10.350	6300	10.500
6015	10.025	6090	10.150	6240	10.400	6330	10.550
6020	10.033	6120	10.200	6250	10.417	6360	10.600
6030	10.050						

TABLE X.—MONOCULAR JUDGMENT OF DISTANCE USING SIX-METER STEREOSCOPE.

Judgment Was Made by the Differences in Size of the Retinal Images of the Two Rods.

No.	Name	Age.	Vision	Correct Judgments at the Following Depth Differences					First Noted One Rod Larger When Depth Difference was	Monocular Threshold	Represents Visual Angle Difference of	Binocular Threshold	Represents Binocular Parallactic Angle of
				180 Mm.	210 Mm.	240 Mm.	270 Mm.	300 Mm.					
1	J. N. B.	44	R. 20/15		50%	90%	100%		240 mm.	240 mm.	13.2″	10 mm.	3.4″
2	H. M. J.	34	R. 20/15	40%	60%	70%	90%		240 mm.	240 mm.	13.2″	5 mm.	1.9″
3	P. D.	43	R. 20/10	55%	35%	65%	70%	95%	210 mm.	270 mm.	14.7″	30 mm.	11.2″
4	C. K.	23	R. 20/15	40%		50%		100%	240 mm.	300 mm.	16.4″	15 mm.	5.6″
5	E. C. C.	47	L. 20/20	40%	50%	60%		100%	240 mm.	300 mm.	16.4″	30 mm.	11.0″
6	E. W. H.	33	R. 20/15	60%	60%	30%		90%	210 mm.	300 mm.	16.4″	10 mm.	3.8″
7	L. B. G.	38	R. 20/15			60%		70%	300 mm.	300 mm.	16.4″	15 mm.	5.3″
8	P. W. C.	46	R. 20/15	10%	50%	30%	35%	10%	270 mm.	Over 300 mm.	Over 16.4″	10 mm.	3.7″
9	O. A. B.	41	R. 20/15		30%		50%	60%	270 mm.	Over 300 mm.	Over 16.4″	5 mm.	1.8″
10	M. B. C.	20	L. 20/20	50%		45%		65%	300 mm.	Over 300 mm.	Over 16.4″	R. Eye Blind	
Average		37	20/15	48%	48%	58%	69%	77.5%	250 mm.	Over 285 mm.	Over 15.5″	14.4 mm.	5.3″

DISCUSSION.

DR. ALEXANDER DUANE, New York: I had the opportunity of visiting the laboratory and inspecting the apparatus that Captain Howard has described, and I derived three impressions from it. The first was that of the extreme precision of the test. In fact, as Captain Howard says, a very slight variation in the distance between two objects seen at six meters is instantly perceptible to the observer. The apparatus seemed very simple and the test very satisfactory, accurate and precise. The second impression was the convincing evidence that monocular vision gives us no perception of depth, in the proper sense of the word. That is supposed to be a truism, yet it has been denied recently, and it is satisfactory to see the convincing proof of it that we get from an apparatus like this. On closing one eye that delicate perception of depth that one had before immediately vanishes, and one could not tell where the rods were. The third impression was the most satisfactory of all. It was an impression of stimulation and inspiration of stimulation derived from visiting an institution of this kind, and seeing what the men were doing, the spirit in which the investigation was conducted by all the men, the whole-heartedness and unselfishness with which they went into it; and of the inspiration that came to the onlookers to go and do likewise. I wish that more had seen it. If they had, they would join in the wish that this work might be continued.

DR. E. E. BLAAUW, Buffalo: I am glad that the subject of binocular single vision has been considered, and that Dr. Howard has come to the conclusions I put down in my paper before the Section of Ophthalmology of the A. M. A. in 1917. I should like to have the inside of the instrument entirely black, and the arrangement of the light or lights should be such that no shades are formed. That seems to be easy by bringing in the case some electric lights. The sticks of Brooksbank James are not so preferable, as they are relatively too thick; Schoute of Amsterdam has them changed to white threads. I am glad that the essayist states that the fundamental judge for B.S.V., or so-called stereoscopic vision, is the binocular parallax. It is interesting to see the change of opinion, and with that the progress. In the meet-

ing in 1917 the opinion was expressed, that "binocular single vision was of very little value." This subject depends entirely on physiology, the basis of ophthalmology, as well as of the whole science of medicine.

Brooksbank James' instrument, and the valuation of B.S.V., is not only of value for aviation but has also a great practical value in life. With it we can measure the loss in centimeters and millimeters, if an accident has occurred and the patient has had this faculty measured before. I would suggest that the same instrument be used by all ophthalmologists, and that the right measurements should be studied before adopting a definite one.

DR. ALLEN GREENWOOD, Boston: Professor Spearman, of London, has devised an instrument in which there are three posts instead of two, the third on a movable carrier between the others. One cannot tell with one eye whether this middle post is between the others or not, but with two eyes one can. The patient can turn the wheel that slides the middle post forward and backward so as to have the middle post appear the same distance from the eye. The accuracy of his binocular judgment can then be read off on the scale provided.

DR. W. H. WILMER, Washington, D. C.: The description of Spearman's apparatus was in the part of the paper that I did not read. That is, I described Spearman's original apparatus, which to my mind is better than his last. In the latest apparatus the test-objects are of milk glass. They can be turned at will to get different angles. Practically, the apparatus described by Dr. Greenwood is better. Professor Spearman, who is very fond of correlations, has found a good correlation between this test and good flying. He finds that practically all of his good fliers qualify well, and nearly all of those who fly badly fail to judge distances well by this test. Its practical use has been of great value.

DR. C. F. CLARK, Columbus, O.: I was greatly impressed with the suggestion that there may be a permanent school for the study of these subjects which in time might bring the science of physiologic optics to a higher standard of perfection, and, as the Government is at times somewhat

capricious in the matter of appropriations for such objects, it has occurred to me that, as it is largely a matter of measurements and standardization, if the Government fails to take in hand and continue the work it has begun we might appeal to the Bureau of Standards, which could perhaps be induced to continue these investigations.

DR. CONRAD BERENS, JR., New York: When research work was started at Mineola, we were all deeply interested in developing a practical method for testing the pilot's ability to judge distance, for we realized that the test with the stereoscope was not ideal. We knew the complexity of the problem, and found that some men who had lost one eye could still make judgment of distance accurately and quickly, while others could not, and we thought an apparatus that would record time or reaction time in making judgments would be valuable. An apparatus which recorded reaction time and also took into consideration the factor of motion was finally constructed, but unfortunately too late to be put to practical test. Captain Howard is to be congratulated upon having been able to perfect and test out his apparatus under the handicap of war conditions.

DR. F. H. VERHOEFF, Boston: What Dr. Howard has determined is the minimal perceptible binocular parallax. It seems to me that it is questionable whether this test will decide the ability of the aviator to estimate distance. We want to know with what accuracy he judges distance by binocular vision, and not alone the slightest distance that he can recognize. No one, so far as I know, has ever attacked this problem. Years ago I gave some thought to the matter, but was unable to devise an accurate method of making the test.

Theoretically there are some objections to Dr. Howard's method, but practically I do not believe they are sufficient in any way to vitiate the accuracy of his results. One is that the possibility of judgment by monocular parallax has not been completely excluded, particularly with reference to the edges of the opening in the box. Another, less important, is that no allowance has been made for variation in apparent size with distance. I think that it would also be well to determine, if possible, the maximal binocular parallax

perceptible as depth. Some people get double vision when the binocular parallax is great, and an interesting question is whether they can still make accurate judgments of distance in the presence of this physiologic diplopia.

DR. DAVID W. WELLS, Boston: I should like to hear Captain Howard's opinion of the relative value of Dr. Cohen's instrument and the one he uses; and also to ask whether the differences in the normal stereoscopic acuity, as figured out by James and himself, might be due to the fact that James used white and he black rods. Is it possible that this smaller angle of stereoscopic acuity may be due to some monocular estimation of depth, from some shadow which might be inherent in the black rod on the white ground, etc.? It seems to me that Dr. Cohen's instrument, which does away with the rods altogether, and substitutes simple lights, which are movable in the anteroposterior direction, theoretically, at least, is a more exact piece of apparatus.

CAPTAIN HARVEY J. HOWARD, M.C., Mineola, L. I.: In regard to what Dr. Blaauw has mentioned, I should state that I did use dead black paint on the apparatus; also the rods were painted black. In fact, the only white surface seen was the background of white cardboard which gave a strong indirect and uniform light upon the rods from behind.

As for the apparatus devised by Dr. Spearman, which Dr. Wilmer has mentioned, I have not had an opportunity to see a description of it. Has any been printed?

DR. WILMER: The description of this apparatus I have given in my paper. I did not have time to read it.

CAPTAIN HOWARD: Three posts were mentioned by Dr. Wilmer as the test-object in Dr. Spearman's apparatus. I wish I had had time to-day to show the great advantage of two posts over three. I finally decided upon two posts or rods because by this means it is possible to discover those men who have a tendency to project one rod nearer than the other, while the other was really the nearer. Among one hundred and six men examined there were twenty-three who incorrectly projected one or the other of the two rods. If I had used three rods, it would have been impossible to have discovered this fault. After study of the complete data of

all my cases I found that there was a reason for projecting one rod nearer than the other. It was due largely to a difference in visual acuity of the two eyes. In my opinion it would be better for an aviator to have 20 20 vision in each eye than 20 20 in one and 20 10 in the other; because almost without exception I found that a man with a difference in visual acuity between the two eyes is a poor judge of distance, *i. e.*, in using the binocular parallax test. There are other causes which I have discussed in my paper.

As to motion parallax, which Dr. Blaauw mentioned, it should be remembered that this is a factor which is extraneous to the individual and helps us all alike, and therefore cannot properly be considered among the factors which make for individual differences. As to time exposures or methods of recording time, I should say that I have recognized the value of this factor. In fact, in a new apparatus which I have designed, and which Bausch and Lomb are now making, I have included a Graflex shutter capable of any time exposure up to 1 1000 second. In all my experiments I used a screen or a shutter. I might mention that the value of the shutter in the simple apparatus I found to be so great that I decided that the whole subject of reaction time in the judgment of distance ought to be gone into.

In regard to what Dr. Verhoeff has said about the visual angle and judgment of distance, I would say that I have proved to my own satisfaction that the visual angle, and consequently retinal image, is a far less important factor than the binocular parallax in the judgment of distance. For example, I tried ten men in two different ways: with both eyes open, and with only one open. I found that the depth difference threshold varied from an average of thirteen millimeters when both eyes were open to over two hundred and eighty-five millimeters when only one eye was open.

Regarding Dr. Cohen's apparatus, I should say that it has been impossible for me, in this paper, to go into the bibliography and discuss what I have read. My paper would have been too long for this meeting. I hope at some time in the future to take up the subject of the bibliography of "Depth Perception." I was interested in seeing Dr. Cohen's apparatus a few months ago. My principal criticism, and of which I told him at the time, was that the test-

objects were superimposed. I think I have proved in my paper that one cannot determine the depth difference of superimposed objects until one gets into the realm of the visual angle. I have discussed this part of the subject quite fully in my paper.

THE MADDOX ROD SCREEN TEST.

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(By Invitation)

Introduction. It has been said by Colonel W. H. Wilmer that the safety of the flier depends more upon good extraocular muscle function than upon good visual acuity. Under the stress and fatigue of flying the aviator with hyperphoria or a divergence excess is apt to have his error become manifest as a diplopia which would make a safe landing nearly impossible. Headache, vertigo, and nausea, which commonly accompany some of the disturbances of motility of the eye, are not compatible with the efficient service that is expected from the man who flies. For these reasons the examination of the extraocular muscles must be conducted with the greatest care in the air service in order to uncover any defect which might jeopardize the life of the aviator.

During the past year several tests for the detection of heterophoria in the primary position were approved by the Ophthalmological Department of the Medical Research Laboratory. All of these except the Maddox rod, screen, and parallax tests were finally eliminated in an effort to reduce the ophthalmologic equipment to a compact war basis. In the course of the examination of hundreds of men the Maddox rod test, because of its great simplicity and easy application, was favored to the partial exclusion of other tests.

At this stage of the laboratory work several of the examin-

ing surgeons began to question the accuracy of the Maddox rod test. The evidence submitted by them showed that some aviators could not see the light and the line at the same time; that others saw the line of light moving about so erratically that no measurements could be taken; that still others showed a tendency to fuse the line with the light, indicating orthophoria when some form of heterophoria was known to be the true condition.

Criticisms of the Maddox Rod Test.—A review of American ophthalmic literature reveals many criticisms of the Maddox rod test which support these observations. Duane,[4] in discussing the routine examination of the eye, says that the test is not as reliable in his hands nor as accurate as the screen and parallax tests. He finds it is apt to indicate an excess of esophoria and a tendency in some patients to fuse the line with the light. Later[5] he repeats this criticism and estimates the amount of excessive esophoria shown by the test to be about one degree. Howe,[7] in his elaborate study of the eye muscles, places the Maddox rod third in the list of tests arranged according to their clinical value. In analyzing some tests for heterophoria, Stevens[11] finds that the tendency of the line to fuse with the light is so great that orthophoria is often shown when heterophoria exists. Weeks[13] calls attention to the fact that some patients have difficulty in seeing the line of light. On the basis of some comparative tests Weymouth[14] concludes that the Maddox rod shows an excessive amount of esophoria.

In spite of all this authoritative criticism of the test the Maddox rod continues in general use. It is to be found in almost every trial-case and is included in the equipment of most of the new combined phorometers. When we consider that studies of heterophoria, based wholly or in part on this test [3, 10] are being added constantly to our ophthalmic literature, it becomes a matter of importance to determine its accuracy. This experimental work was begun for the

purpose of investigating these criticisms of the Maddox rod test, analyzing the causes back of them, and suggesting, if possible, some remedial procedure.

Control Tests, Observers, and Apparatus.—The screen and parallax tests, recommended by Duane, were used as control tests. The observers were chiefly aviators with normal visual acuity and normal-functioning ocular muscles. The apparatus used was a DeZeng phorometer trial-frame, equipped with a pair of Maddox rods and a pair of Risley rotary prisms. The spot of light was obtained from a frosted Mazda lamp surrounded by an opaque chimney. An iris diaphragm in the chimney permitted the size of the spot to be regulated. This lamp was mounted on a movable floor standard, which could be adjusted for height. The tests were made with the eyes in the primary position, looking at the light 20 feet away. For the purpose of some experiments a condition of artificial heterophoria was produced by placing a trial-case prism in the trial-frame of the phorometer. This prism was always placed before the eye that was covered by the Maddox rod. When necessary to study the effect of reduced visual acuity, convex lenses were placed before one or both eyes. The effect of accommodation on the test was studied by placing concave lenses before one or both eyes. In the following report "the light" or "the spot of light" refers to the light 20 feet away at which the observer looked during the test; "the line" or "the line of light" refers to the line of light seen by the observer when looking through the Maddox rod.

Scope of the Investigation.—For the purpose of study, the criticisms of the Maddox rod test were grouped under four heads: I. Excessive esophoria. II. Fusion tendency. III. Instability of the line. IV. Inability to see the line.

I. EXCESSIVE ESOPHORIA.—One hundred men were examined for the purpose of determining if the Maddox rod test does actually show more esophoria than the screen

and parallax tests, which were employed as controls. An analysis of the result of the examination gives 72 men who have $\frac{1}{2}$ to 2 prism diopters more esophoria, or less exophoria, by the Maddox rod test than by the control tests.

This fact being established, a study of the various factors entering into the test was made for the purpose of discovering the possible causes of the excessive esophoria. The factors were gradually eliminated by experiment until the following two remained: A. Latent hypermetropia; B. False projection of the line.

A. Latent Hypermetropia.—A group of emmetropes free from heterophoria was selected for the purpose of determining the effect of artificial hypermetropia on the Maddox rod test. With the Maddox rod in place before one eye, a one diopter concave lens was placed before the other eye. The test registered esophoria immediately, showing that the light-fixing eye, which was covered by the lens, controlled the finding. On removing the lens the test showed orthophoria. On placing it before the eye covered by the Maddox rod the test still registered orthophoria, showing that the light-fixing eye still controlled the finding. With the lens still in place before the eye covered by the Maddox rod, the observer was urged to concentrate his attention upon the line and disregard the light. After considerable effort he was able to focus the line through the concave lens and the test registered esophoria. The accommodative effort necessary to do this, however, was so much greater than the effort necessary for light fixation that, at the first wavering of attention from the line, the light was again fixed and the test showed orthophoria. The addition of a great variety of lenses to one or both eyes of the observers used in this experiment confirms the conclusion that a hypermetropic condition of the light-fixing eye, by stimulating accommodation and convergence, always affects the findings of the test in favor of esophoria. A hypermetropic condition of the eye covered by the Mad-

dox rod does not influence the result of the test unless fixation is switched from the light to the line.

Attention is now called to the fact that persons with unequal, uncorrected hypermetropia usually use the eye with the lesser refractive error for the purpose of clearest vision. If this eye with the lesser amount of hypermetropia be covered by the Maddox rod, the result of the test will be based upon the greater amount of hypermetropia in the light-fixing eye. Such a finding will show more esophoria than actually exists.

The experiment emphasizes the necessity of having the patient wear his refractive correction during the test for heterophoria.

B. False Projection of the Line. Some observers apparently see the line of light nearer than the source of light 20 feet away. On being questioned they are apt to say that the line passes in front of the light. The recorded answers of 50 observers show that not one thought the line was as far away as the light. Some saw the line a few inches from the face. The majority projected it from 3 to 10 feet away. It is not possible for an observer to give close attention to an image which he believes is 10 feet away without making some effort to focus his eyes for that distance. Peterson,[9] in analyzing a distant light phenomenon, says: "Normally in spatial perception our focus is on the object which receives the attention." If the observer visualizes the line nearer than 20 feet and focuses upon it where he imagines it to be, the accommodative effort he makes produces a convergence which in turn increases the amount of esophoria.

The experiments made in studying the false projection of the line indicate that it is more apt to occur if the line is seen indistinctly. A reduced visual acuity, for example, causes the observer to try to bring the line into sharp focus, which results in esophoria if he is able to make any accommodative effort. An indistinct line, caused by irregularities

in the surface of the glass of the Maddox rod, produces the same effect. A large number of Maddox rods have been tested for such defects and for prism. A separate report will be made on these defective rods.

The natural precaution to be taken against false projection of the line is to keep the observer's attention fixed on the light as continuously as possible during the test.

II. FUSION TENDENCY.—There is little information available on the subject of the fusion of more or less dissimilar retinal images. It is not known how dissimilar the two retinal images must be in form, color, and distinctness to prevent fusion. In addition, I can find no record of any experimental work done on the fusion tendency as distinguished from actual fusion.

The present investigation has determined that the spot of light and the line projected by the Maddox rod form retinal images sufficiently dissimilar in form to prevent actual fusion in the measurement of esophoria and exophoria. An apparent fusion in the measurement of hyperphoria is shown in a number of the tests.

It has been demonstrated by the experiments that the fusion tendency is increased by certain conditions which may surround the Maddox rod test. They are: A. The exclusion of extraneous retinal images. B. Horizontal and vertical lines in the background. C. Additional sources of light. D. The intensity of the spot of light.

A. The Exclusion of Extraneous Retinal Images.—When the room in which the test is being made is darkened so completely that the light and the line are the only two outstanding sources of retinal stimulation, the fusion tendency is very strong. The light and the line are double images causing confusion and interfering with vision. The natural reaction of the observer to this unusual condition is to avoid the double images by an attempt at union or fusion.[6]

When the room is not darkened during the test, the eye

fixing the spot of light is diverted by the extraneous images of numerous objects and outlines in the background. The line and the light, now of lessened brilliancy, are no longer the only sources of retinal stimulation and the fusion tendency is decreased. Exceptions to this conclusion are considered under the next two captions.

B. Horizontal and Vertical Lines in the Background.—The line of light fuses readily with horizontal and vertical lines situated near the point of light.[12] The vertical lines of door and window casings, cabinet edges, etc., even when situated 12 inches or more away from the spot of light, may be fused with the line of light. The most vicious of these lines is the one projected by the vertical standard which supports the lamp used in the test. This form of light equipment, which is manufactured particularly for the purpose of ocular tests, has escaped general suspicion. One was in use in this laboratory for several months before attention was directed to this inherent fault and its construction.

C. Additional Sources of Light.—The spot of light arranged for the purpose of the test should be the only source of illumination visible to the observer. Other sources of illumination, such as overhead lights, table lamps, and partially shaded windows, are seen through the Maddox rod as supernumerary lines of light, any one of which may be fused with the spot of light and give a false finding.

D. Intensity of the Spot of Light.—When the spot of light is very brilliant, an intensely bright line is formed and the fusion tendency is then greatly increased. This is particularly true when the room in which the test is conducted is dark. A spot of light of very moderate intensity is sufficient for the purposes of the test in a semi-darkened room.

The effort to see the line and the light simultaneously naturally stimulates the fusion tendency. When the observer concentrates his attention upon the light and disregards the line as much as possible, no movement of the two

images takes place to indicate a fusion tendency. The same is true when the observer's attention is concentrated upon the line to the exclusion of the light.

III. INSTABILITY OF THE LINE.—In the Maddox rod test for esophoria and exophoria the line is frequently observed to lack stability. Instead of being in a fixed position in the background, it is seen in a constantly varying lateral relation to the light. Patients speak of this phenomenon as a "wavering" or "dancing" of the line. A similar movement of the light is rarely observed. This is due to the fact that the light is seen in its proper relation to other objects in the room. The eye covered by the Maddox rod, however, sees no objects in the room which help to give the line a fixed position. For this reason any change in the lateral distance between the light and the line is interpreted as a movement of the line alone.

The experimental study of this phenomenon demonstrated that the movement was checked when the observer concentrated his attention and fixation on the light, and at the same time disregarded as much as possible the image of the line. Similarly, the movement was checked when the line was fixed and the image of the light disregarded. It follows from these facts that movement of the line may result from an effort to fix both the light and the line at the same time or as a result of fixation which alternates between the light and the line.

In simultaneous fixation the movement may be due to (*a*) The fusion tendency. In alternating fixation it may be due to (*b*) unequal hypermetropia; (*c*) false projection of the line.

The influence of these factors on the test has already been discussed so completely that their relation to instability of the line is apparent.

The data collected in this investigation indicate that another cause of movement of the line may be connected

with the habitual use of one eye for fixation. This phase of the investigation will be made the subject of a separate report.

IV. INABILITY TO SEE THE LINE.—The causes of failure to see the line in the Maddox rod test are usually simple and self-evident. They are reviewed here chiefly for the purpose of completing this critical study of the test. They may be grouped as follows:

(1) Malposition of the Maddox rod; (2) Bright illumination of the room; (3) Dimness of the spot of light; (4) Non-essential sources of light; (5) Poor vision in one eye; (6) Habitual suppression of one image; (7) Poor vision in both eyes.

1. Malposition of the Maddox Rod. The single Maddox rod must be very carefully adjusted in front of the eye to bring the line in the field of vision. Some of the newer multiple rods, because of their small diameter, require unusual care in adjustment. A more distinct line is secured when the rod is placed close to the eye.

2. Bright Illumination of the Room.—If the test is made in a brightly lighted room, the line is not easily seen in contrast with the surroundings. In a very dark room both the light and the line are seen more distinctly, but the manipulation of the apparatus is accomplished with unnecessary difficulty. The test is best made in a semi-darkened room.

3. Dimness of the Spot of Light.—A bright source of light, diffused by ground or milk glass, is most suitable for the test. Such a light, when screened down to a diameter of from 8 to 10 mm., will irritate the eyes very little and will be seen through the Maddox rod as a line bright enough to be distinguished easily in a semi-darkened room.

4. Non-essential Sources of Light.—When sources of light, non-essential to the test, are located in front of the patient, several lines of light may be seen through the Maddox rod. The particular line belonging to the spot of light often is not

located under these conditions, and the test is completed with the wrong line.

5. Poor Vision in One Eye.—The eye covered by the Maddox rod may have such poor vision that the line cannot be seen distinctly enough to perform the test. The obvious remedy is to place the rod before the better seeing eye.

6. Habitual Suppression of One Image.—When the image of the non-fixing eye is habitually suppressed, the Maddox rod test fails because the test depends upon the relation between two images which must be seen at the same time.

7. Poor Vision in Both Eyes.—When the visual acuity of both eyes is greatly reduced, the test may fail entirely because neither eye, when covered by the Maddox rod, can see the line distinctly.

While this experimental study was in progress the data collected from day to day were analyzed for the purpose of discovering some common cause of the excessive esophoria, the fusion tendency, and the instability of the line, which constitute the chief criticisms of the Maddox rod test. The conclusion was reached that these faults depend chiefly upon the effort of the observer to fix both the light and the line at the same time or to alternate his fixation between them. It was but another step to apply the screen to the test as a means of controlling the observer's fixation. The use of the screen to cover the eyes alternately, as in the screen and parallax tests, obviously would not help here because alternate fixation is a cause of part of the error. The choice then lay between permitting the observer to fix the light or to fix the line during the test. Line-fixation was regarded as objectionable because it induced false projection in some cases. It seemed better to consider the line as a false image, the position of which was to be determined in relation to the light. This view of the test definitely gave the rôle of fixation to the eye which sees the light and directed that the screen be used to prevent line-fixation.

I am able to find but one reference to the use of a cover in connection with the Maddox rod test.[1] No originality is claimed for the general idea, but the technic of the test is probably sufficiently new to warrant a detailed description of the procedure.

THE MADDOX ROD SCREEN TEST.—The observer is seated facing the light, which is at the height of his eyes and six meters distant. The Maddox rod may be held in position by a trial-frame and the measurements made with square prisms or those found in the trial-case. The test is much simplified and greatly facilitated by the use of a modern phorometer trial-frame, equipped with a double multiple Maddox rod and a double Risley rotary prism. This apparatus is brought closely in front of the observer's eyes and adjusted to a horizontal position by means of the spirit-level. The phorometer is not used to measure the amount of heterophoria, because its binocular prisms deflect the visual axes of both eyes and consequently leave neither one in the primary position. Both the Maddox rod and the rotary prism are swung into position before one eye, allowing the other an unobstructed view of the light. It is a good idea to set the rotary prism 4Δ or 5Δ off the zero mark in order to deflect the line at the beginning of the test. This will serve to expose any one who has been coached to say that the line passes through the light.

A card about 6 x 9 cm. is used as a screen. This is moved from one eye to the other a few times to ascertain if the observer sees both the line and the light. If the line is not seen readily, the Maddox rod is readjusted by centering it carefully in front of the pupil. Some further darkening of the room may be necessary to render it visible.

When the observer sees both the line and the light easily, the test is begun by holding the screen in front of the Maddox rod to shut out the image of the line. The observer now sees only the light. After he has fixed it for several seconds the

screen is removed for an instant and quickly replaced. In that brief interval the observer should see the line and be able to locate it with reference to the light. After one or two brief exposures he will be able to say, in a test for lateral imbalance, that the line is to the right or left of the light or possibly through it. He is then instructed to grasp the milled head that rotates the prism and turn it to bring the line directly through the light. To enable him to do this, the screen is removed from the eye at intervals and quickly replaced. Finally the observer will have rotated the prism enough to cause the line to pass through the light every time he sees it when the screen is removed. The number of prism diopters necessary to deflect the line through the light is read from the scale of the rotary prism.

The result of the test will be more accurate if the eye that fixes the light is in the primary position and not deflected from it by a prism. It is for this reason that the measuring prism is placed always before the eye that is covered by the Maddox rod. The Risley rotary prism is convenient because it enables the observer to make the necessary prism correction himself.

Attention is called to certain merits of the procedure described. One eye fixes the light, while vision of the line by the other eye is prevented except for brief intervals. The eye under cover takes a position that is influenced by a minimum of the innervation habitually required for binocular vision.[2, 3] The removal and replacement of the screen can be done so rapidly that the image of the line fails to stimulate the retina enough to cause readjustment of the visual axes in the interest of binocular vision, yet such exposure is long enough to permit the line to be seen for the purpose of the test.

The test offers one very interesting variation: either the right or the left eye may be selected to fix the light. Each individual can thus be tested in two ways and two sets of

measurements be obtained. The variation in these double findings and the relation of the "sighting" or "dominant" eye to the test are being studied and will be made the subject of a later report.

Experiments lasting several months demonstrate that this test is more accurate than the accepted Maddox rod test. The results obtained with it compare favorably with those of the screen and parallax tests. This high degree of accuracy, combined with the simplicity and rapidity of application of the test, has caused its adoption by the Medical Research Laboratory.

CONCLUSIONS.

1. The Maddox rod test, because of its easy application and the simple nature of the observation required, enjoys a popularity and wide-spread use among ophthalmologists.

2. Studies of heterophoria, based wholly or in part on Maddox rod findings, are constantly being reported in ophthalmic literature in spite of some serious criticisms of the test.

3. The test has been condemned chiefly because it shows excessive esophoria, a tendency to fusion, and an instability of the line of light.

4. These faults of the test have been verified and the underlying causes studied.

5. The Maddox Rod Screen Test, a simple modification of the usual procedure, gives results that are accurate and free from the above criticisms.

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DISCUSSION.

DR. ALEXANDER DUANE, New York: I have long used the cover test in the way that has just been described, in conjunction with the Maddox rod, which I now seldom employ, and I have found the same method useful with any test employed for determining diplopia, *e. g.*, with the red glass. Often with the latter we get a diplopia, which is apparently neutralized by a certain prism, and yet we can afterward put on prism after prism, and the patient's eye will accommodate itself to each one, so that we are uncertain which one is the true measure of the diplopia. In this case if we wish to get the right measure of diplopia the best thing to do is to put a screen in front of one eye, when the prism is put over the latter; then suddenly take the screen off, and see if the double images coincide, and, if not, repeat the test with another prism behind the screen until they do.

DR. JOHN E. WEEKS, New York: I should like to ask the gentleman whether there is any objection to placing a colored glass in front of the eye before which the Maddox rod is not placed (over the free eye), and whether that would not obviate to a large extent the tendency to a change in the position of the line in relation to the light in an effort at fusion. In regard to the eye before which the Maddox rod should be placed, especially when dealing with eyes that are defective in vision, it has been my practice to use the Maddox rod over the eye with the more distinct vision, obtaining,

in that way, the desired information in the quickest possible time.

CAPTAIN PERCIVAL DOLMAN, Mineola, L. I., N. Y.: There is no objection to the use of a red glass for the purpose of coloring the light. Such a procedure is advocated by Dr. Maddox. Experiments made with the test just described indicate that a colored glass placed before the eye which sees the light does not modify the result of the test and serves only to make the light less intense. I am not prepared to make a general statement at this time that the Maddox rod should be placed before one or the other eye. In a specific case, where the vision of one eye is greatly reduced, the Maddox rod should be placed before the better seeing eye.

A CONTRIBUTION TO THE STUDY OF DARK-ADAPTATION.

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(By Invitation.)

Vision under ordinary conditions and vision under extremely low intensity of light present quite different sets of phenomena. The latter phase of vision has heretofore been of interest from the diagnostic standpoint, and has been investigated and discussed as a problem in visual physiology.

This problem has related itself mainly to the demonstrable anatomic changes corresponding with exposure of the eyes to light or darkness, notably the presence or absence in the rods of the light-fugitive visual purple, the variations in the shape of the pigment cells and in the distribution of their pigment, and the possible shift in the position of the cones. Of these, the phenomena connected with the visual purple have been correlated with certain experimental changes in the vision of light and color characteristically related to the

change between high and low light-levels, and have given rise to the theory of dual function. Stated briefly, this theory assumes that sensations of color are due entirely to changes resulting from the incidence of light on the visual cones. Colorless light-sensation mediated by the cones is also admitted; but sensitiveness to color is denied the rods which are held to give only light impressions undifferentiated in color, and to be capable of extreme enhancement in sensitiveness after a period of removal from strong light. The changes in function that take place in normal vision in transition from high (daylight) to low (twilight or night) intensities of light can be enumerated briefly:

1. Color, as a visual quality, disappears. Objects are seen as lighter or darker, but not as of different colors.

2. Concomitantly a shift of sensitiveness, with relation to the position in the spectrum, takes place. The bright spectrum presents all the rainbow colors, and has its brightest part in the yellow. The dim spectrum is devoid of color. At its red end it has ceased even to be luminous, and its brightest point is found to be of shorter wave length (*i. e.*, farther toward what was the green) than the brightest part of the daylight spectrum.

3. An enormous enhancement of the absolute sensitiveness to light takes place. This is progressive, and when measured is found to be rapid at first, then slower, and is found to become stationary in an hour's time or less.

It is the increasing sensitiveness of the darkened eyes, or dark-adaptation, which concerns us here. This phenomenon has long interested the student of visual physiology and has been investigated as a possible aid in the diagnosis of certain conditions involving the retina. Further than this it has not had technical importance. In times of peace it is a simpler expedient to provide light than to try to see in the dark. The way of warfare is different, and to choose for the enemy unfavorable natural conditions which one himself

has learned to meet is a part of good strategy. To orient himself with reference to terrestrial objects the aviator cannot depend upon hearing. The roar of his motor would make this impossible, even though otherwise he is not too far away. The experiment of feeling his way is unintentional, because it is usually fatal. Both with respect to objects on the earth and to other airplanes the aviator must rely upon his vision alone. When night flying became a part of military strategy the classification of aviators on the basis of night vision became a problem worthy of study.

In attempting to find the lowest limit of light sensitiveness we at once encounter the fact that the light threshold is, apart from irregular variations, a variable quantity. The subject, taken into a dark room, at first requires an amount of light which is many times that necessary a few minutes later. Exact researches have shown that the factor may easily be several thousand. In coming from bright daylight into the dark room the threshold has been shown in normal individuals to be 1500 to 8000 times that obtained an hour later, the subjects in the mean time remaining in the dark.

It has also been shown that the rate at which the threshold amount of light decreases is not always the same for the same individual, but depends upon the duration and intensity of the light to which the subject's eyes have been exposed during a perhaps indefinite period just prior to the experiment. The present work proposed investigating the quantitative relations regarding this last point, as well as determining the ultimate light-sensitivity of individuals and their characteristic mode and rate of recovery from the partial and temporary blinding due to light. The aim was to arrive at some idea of individual variations in these respects as preliminary to the devising of a practical and valid method of testing.

The detailed procedure used in conducting the experimental work at present under consideration will appear in

another place. An outline of the essential facts will be given here.

The subject coming into the experimental room is seated facing the adaptometer (Fig. 1). On a level with his eyes, and 52 cm. away, is a small red light, dimmed as far as is consistent with certain fixation upon it in the dark. The test pattern is in the same vertical plane as the fixation-point, its center 12 cm. directly below the latter. The test pattern is best described as a square, 7.5 cm. on each side, from which the middle third is removed, leaving two parallel rectangles, 7.5 x 2.5 cm., with a dark space 2.5 cm. wide separating them. The center of the pattern is 13° below the point of fixation, and its extreme limits subtend about 8° horizontally and vertically in the visual field. This pattern is projected upon a sheet of milk glass, from the side away from the observer, by a device which is essentially a small stereopticon. The latter is enclosed in a light-tight box, the milk glass being a window set in one end. The amount of light projected, and hence the brightness of the test pattern, was controlled and measured by means of a gelatin smoke wedge. The form of the pattern is determined by openings in a thin slip of brass, which represents the "slide" in the stereopticon. Two pairs of openings were used—one with the two rectangles in the vertical position, the other in the horizontal, and the change was made by a horizontal shift of the slide.

(1) As soon as possible after the subject entered the room the latter was darkened and his threshold was taken. This was repeated with approximately five-minute intervals of rest. In twenty or thirty minutes it was found that his threshold had reached a limit and had become constant to within what could be called the margin of experimental error.

(2) When this was assured by the results, the first part of the experiment proper began, involving a measured amount of "blinding." A white screen was set up obliquely before the subject and the center light of the room was turned

FIG. 1. General review of the experimental set-up. The test pattern appears on the square white surface at the end of the adaptometer. Above this is the fixation mark with dry cell attached. The white screen used for the purpose of "blinding" the subject is below in the foreground.

on. The screen subtended 67° vertically and 70° horizontally in his visual field, and its brightness averaged 13 candles per square meter. The subject was instructed to look at the central part of the screen, without especial effort to fixate. At the end of five minutes the light was turned off and the screen removed. In the mean time the test pattern had been set at a certain rather high level of brightness, and the time elapsing between the darkening of the room and the first visibility of the pattern was taken. After that the threshold was taken as before, but with somewhat shorter intervals, until it had reached its former final value.

(3) When this had taken place, the white screen was replaced and the procedure repeated as under (2), with fifteen seconds' exposure to the screen instead of five minutes'.

This procedure was planned with the idea that the first portion would serve two purposes—to give a value for the absolute threshold of the subject and at the same time to bring him to a standard and reproducible state,—that of complete dark-adaptation,—before subjecting him to a standard amount of blinding. Obviously, this latter would mean nothing unless the effects of previous light exposures had come to an end, and there seemed no way of making certain of this but to follow the subject's threshold to a constant value. There seems to be some evidence that even this, as done here, is not adequate. In two cases the experimental order was varied, parts (2) and (3) of the experiment being transposed in order. Comparison of these results with the bulk of the results seemed to indicate that whichever stage (2 or 3) of the experiment was conducted last was subject to a residual effect from the blinding of the foregoing part, in spite of the fact that the subject had, in the mean time, come back to his first ultimate threshold. This was evidenced by a somewhat more rapid recovery in these two cases than was to be expected in part (3), when

this took second place in order, and by a slower recovery in part (2), when this took third place.

A study of the results yielded a set of numerical values which are summarized in Table I. From this it will be seen that the individual variations are quite large on every point. For example, in different individuals the absolute threshold was found as high as 9.95, and as low as 1.34 millionths of one candle per square meter. The mean value for all subjects was 4.97, with a mean deviation of 2.18 millionths, or 44 per cent. of the mean.

TABLE I

	Absolute Threshold	At −15 mm.		70 mm.		50 mm.	
		Recovery time, seconds, after blinding for					
		5 min.	15 sec.	5 min.	15 sec.	5 min.	15 sec.
Largest value	9.95	385	106	542	99	62	25
Smallest value	1.34	86	43	62	36	10	5
Mean	4.97	214	71	233	73	34	126
Mean deviation	2.18	78	16	103	12	11	44

A specimen of the course of adaptation is shown graphically in Fig. 2, the three curves being the graphs of parts 1, 2, and 3 of the experiment, as described, and the intervals of measured blinding being indicated by the vertical dotted lines. The ordinates of the plot indicate the position of the wedge by which the intensity of the light was cut down. The relation between the shift of the wedge and the brightness of the test-pattern is a logarithmic one, such that the brightness is reduced by a constant fraction for equal linear shifts of the wedge. With the wedge at 0.0 mm. the brightness is 0.0272 candles per square meter, which is in effect divided by 2.79 for each 10 mm. shift of the wedge. The relation between these readings in millimeters, and the actual brightness of the test-pattern in decimals of one candle per

square meter, is shown by the comparative scale of ordinates in Fig. 5. The decimal scale alone appears in Fig. 4, and in these two figures the horizontal lines indicate the intervals of a tenfold change in brightness.

Returning to Fig. 2, the absolute threshold is indicated at the height of the first curve by a horizontal dotted line. It is placed at the mean of the three points indicated. The

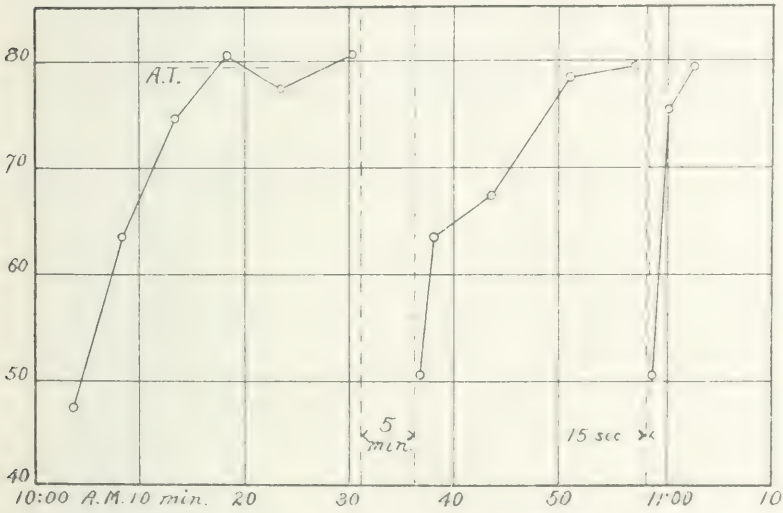

Fig. 2. Specimen plot of experimental data. The first curve was taken without preparation. In this case the mean of the last three points 79.5 mm was taken as the absolute threshold. Its location in the plot is indicated by the horizontal dotted line. The two blinding periods are indicated by the vertical dotted lines.

relation between amount of blinding and the rate and mode of recovery appears from consideration of the next two curves. For a blinding period of five minutes the curves show characteristic differences, as exhibited in Fig. 3, where the results for all 15 subjects are plotted for comparison. These show the various heights of sensitiveness which different individuals ultimately reach, and also show in certain cases quite definite temporary arrests in the progress of

adaptation (*Do, B, Du, Hn*, Fig. 3). Out of a total of 52 adaptation-curves plotted, 14 showed this halt in the rise of sensitiveness very definitely, while in four others it is suggested. To emphasize this the first two curves shown in Fig. 3 are plotted together in Fig. 4, with their common origin at the point where adaptation begins and with the time-scale enlarged fourfold.

In considering the rate of adaptation, that is, the indi-

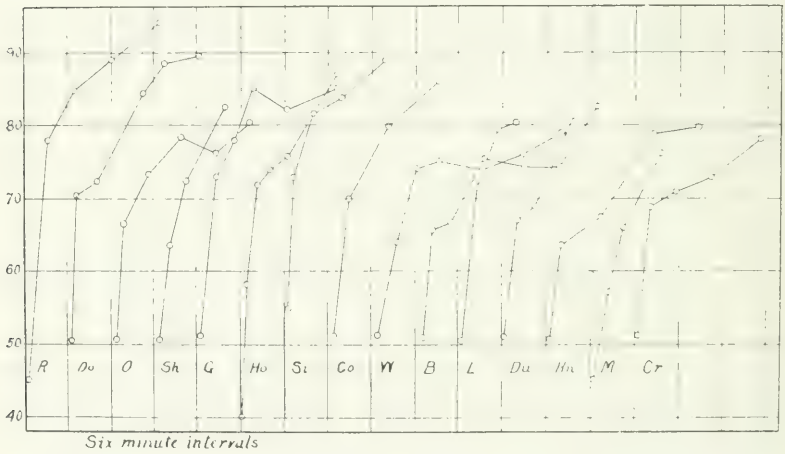

Fig. 3.—The course of adaptation after five minutes' blinding in 15 different individuals. The vertical line in each case is the zero ordinate for the corresponding curve, indicating for that curve the instant that the blinding period closed and adaptation began.

vidual rate of recovery of the sensitiveness temporarily lost in the process of blinding, it is to be said that great variation was found, but the most interesting fact is that the time of return to a fixed point in the scale of sensitivity, estimated from the plotted curve, bears no very definite relation to ultimate degree of sensitiveness which the individual may show. There is perhaps a general trend, as might be expected, in the sense that a subject with a low absolute threshold reaches a given level of sensitivity more quickly and

vice versa, but the exceptions to this are more noteworthy than the rule. In Fig. 5 are plotted the results from four types illustrating this. Subjects *R* and *Si* have low absolute thresholds (high sensitivity), but *R* is slow and *Si* rapid in recovery. Similarly in the case of *W* and *Cr*, whose absolute threshold is, however, high. By examining the steep

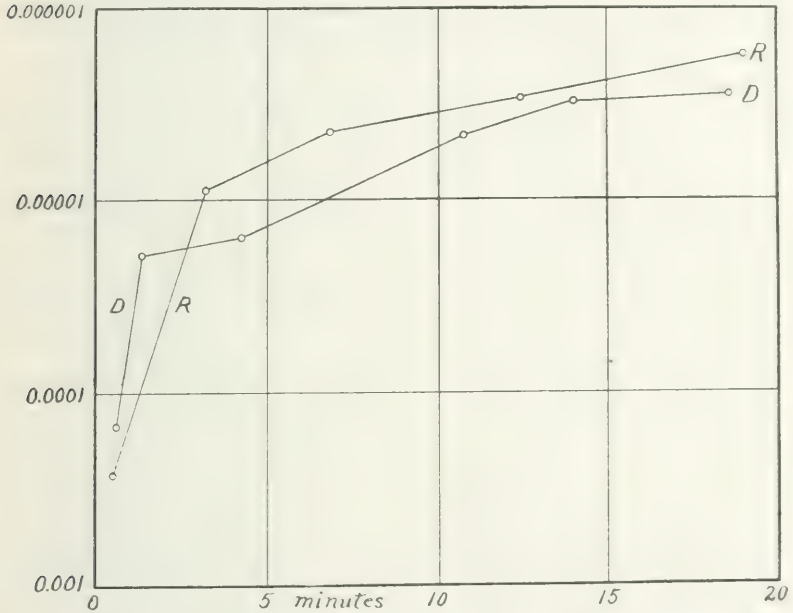

Fig. 4.—Two types of adaptation curve, *R*, "normal" or regular form, *D*, irregular form, showing a halt within the first five minutes and subsequently a more rapid rise.

parts of the curves it will be noted that *Cr* at first recovers more rapidly than *R*, who is by far the more sensitive later on in the course of adaptation.

As to the general difference in the rate of recovery, as dependent upon the duration of the previous blinding, it is to be said that recovery is about three times as fast following the fifteen seconds' blinding as in following the five minutes'

blinding. The course is shown graphically in the right-hand plot, Fig. 5, for the same four subjects. Owing to the rapidity of recovery the data are not as explicit as in the case of slower recovery.

The study of dark-adaptation with reference to the practical use of the eyes at night involves a point of view different from that involved in the study of dark adaptation for the purpose of solving physiologic or diagnostic problems, and a

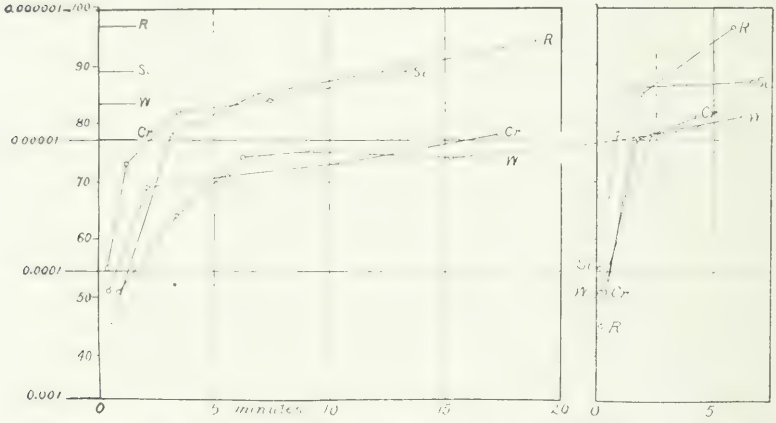

Fig. 5.—Four cases showing typical courses of adaptation: R, high sensitivity, slow recovery; Si, same, rapid recovery; Cr, low sensitivity, rapid recovery; W, same, slow recovery. On the left, after five minutes' blinding: on the right, after fifteen seconds'.

The absolute thresholds for each of the four are indicated near the upper left corner of the figure.

question arises here with especial reference to the aviator. In rating him, shall we consider his ultimate sensitivity, or shall we rate him in the basis of his speed of recovery after blinding? In other words, from this standpoint, which portion of the curve deserves the more exhaustive investigation? It would seem an obvious answer to this to say that the part of the curve to investigate is that which, in general, best represents the illumination conditions existing under

natural light at night. The photometric study of such conditions will be a relevant and interesting topic.

Summary of Experimental Conclusions. (1) Upon investigation of fifteen subjects it appears that the limit of vision in dark-adaptation (the absolute threshold), measured by the least brightness at which gross form may be recognized, is variable within extreme limits expressed by the ratio of 7.4 to 1. These limits lie between 1 and 10 millionths of one candle per square meter.

(2) The rate of recovery, after dark-adaptation, is disturbed by a standard exposure to light, is also variable as between individuals, and by no means always in a sense corresponding with the value of the absolute threshold.

(3) Recovery to the point of visibility of a test stimulus 4.7 times the individual's absolute threshold is in general slower the lower the absolute threshold. This seems to be the consequence of the simple fact that the test stimulus, so chosen, is necessarily the farther below the level of brightness of the blinding surface, the lower the absolute threshold. The extreme individual variations in time for this relative degree of recovery are as 4.5 to 1, and as 2.5 to 1 for five minutes and fifteen seconds, respectively.

(4) The time of recovery to the point of distinguishing a test-object of standard brightness is to be looked upon as a function of two variables: the individual's absolute threshold and his rate of recovery as indicated under (3). For a constant test stimulus 4.7 times the (geometric) mean absolute threshold of all subjects, the extreme variations in time are expressed as 8.7 to 1, and 2.75 to 1 for the longer and shorter blinding periods, respectively.

(5) The times of recovery are less diverse after a short blinding (fifteen seconds at 13 candles per square meter) than after a longer one (five minutes, same), and in the former case recovery takes place on the average in about

one-third the time, or probably less when all antecedent conditions are equalized.

(6) The occurrence, in the course of dark-adaptation, of more or less definite arrests in the increase of sensitivity suggests the independent working of two physiologic mechanisms. These halts occur more or less definitely in 18 out of 52 curves studied, and appear, when distinct, as "terraces" on the rising slope of the curve.

(7) The practical usefulness of data, such as the present, will depend upon a definite photometric knowledge of the minimum light-conditions under which the subject may be called upon to use his vision.

General Results of the Dark-Adaptation Experiments.

The absolute threshold is stated in millionths of one candle per square meter. (Table 1.)

The next two columns give times of recovery, in seconds, of sensitivity corresponding to 4.67 times the subject's absolute threshold ("AT −15 mm.") for the five minutes' and for the fifteen seconds' periods of blinding, respectively.

Similarly, the next two columns ("70 mm.") give the times of recovery to the point of visibility of a stimulus 4.67 times the (geometric) mean absolute threshold. This is $4.33 \times 4.67 = 20.4$ millionths, represented by 70 mm. on the scale.

Under "50 mm. ±," correspondingly, the times of recovery to a threshold of about 159 millionths, the initial result of parts (2) and (3) of the experiment as described in the text.

The times given under "AT −15 mm." and under "70 mm." were estimated from the plotted curves, such as Figs. 4 and 5.

NOTES ON A POPULAR PRESENTATION OF SPECIMENS SHOWING THE MIGRATION OF THE EYE OF THE FLOUNDER AND THE IMPERFECT EYES OF CAVE FAUNA.

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This demonstration of specimens and illustrations will be used simply as an introduction to other data concerning the evolution, and especially the involution, of the eye in animals and in the human species.

The young of the flounder were furnished me by Dr. Moore, Deputy Commissioner of the Bureau of Fisheries. From them it appears that soon after being hatched this fish swims vertically, having one eye on each side of the head. But one eye soon begins to change its position, passing around the head, or in some species through it, finally appearing on the same side of the head as the fellow-eye. Then the creature swims on its side with both eyes looking upward.

These examples of the migrations of the eye constitute simply a rather curious example of the effort of the eye to adapt itself to its environment.

In contrast with this example of evolution the fauna of the Mammoth Cave and of other caves in that part of Kentucky illustrate the involution or degeneration of the eye. Several years ago I made a collection of a considerable number of these species.

Among these creatures the one best known is, of course, the blind fish (*Amblyopsis spelæus*). Although the integument covering the place where the eye should be is smooth

and normal, sections through this region shows that a rudimentary globe still existed. This corroborates the findings of other students of the subject. In one of the fish presented a dissection may be seen of the brain, but the parts associated with the optic tracts do not differ materially from those of other fishes of this genus which live in sunlit waters and which have good eyes. In other words, the process of involution seems to affect primarily the outer structures. These fish had lost not only eyes, but pigment also.

The Mammoth Cave contains a number of crawfish. Most of these have also lost both color and eyes, but one specimen in my collection had lost its color, although some pigment was still visible on the tips of the eye-stalks. A beetle was also found in the Mammoth Cave, said to be a *Cybister fimbriata*. Apparently it was a newcomer. It retained its original dark color and also its eyes. Thus there seem to be two steps in this form of involution: first, the loss of color, then the loss of both color and eyes.

Specimens of blind or partly blind crickets and flies, also from the Mammoth Cave and from other caves in that part of Kentucky, are included in the collection.

These dwellers in caves illustrate the changes which may take place in the eyes of creatures living in an unusual environment. They also emphasize the fact that parts of the human body likewise may undergo involution if our environment is modified by civilization or by our neglect.

Thus we do not notice the gradual loss of the acuity of the sense of smell as compared with other animals. Most persons are ignorant of the degeneration which takes place in the external muscles of the ear. They take little or no interest in the fact, to which Graham Bell has called attention, of "The Development of a Deaf Race" in America. But he has shown that when young deaf-mutes are educated together, intermarriage has often resulted in an increase of the number of certain types.

Fig. 1. Case 1. Notch in upper eyelid due to laceration through the tarsus.

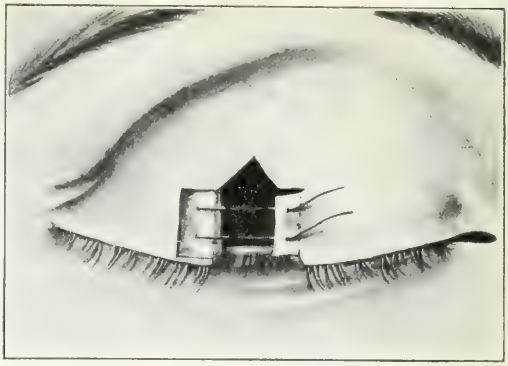

Fig. 2. Case 1. "Halving" operation. Dissection has been made. Mattress suture is shown passing through denuded tarsus on temporal side and flap of skin on nasal side.

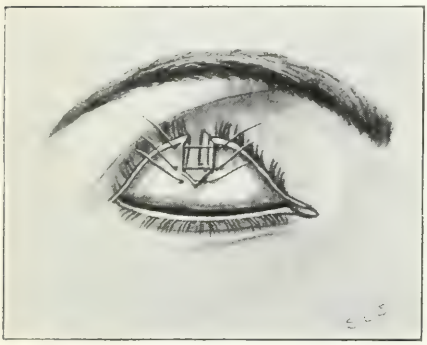

Fig. 3. Case 1. "Halving" operation. Lid everted. Conjunctival sutures ready to tie.

Fig. 4. Case 1. "Halving" operation. Sutures tied. Mattress suture passed through rubber plate. Upper and lower lids sutured together.

Fig. 5. Case 2. Laceration of the lower lid from the inner canthus downward and outward. Fracture of the superior maxilla and malar bones. Dotted lines indicate incisions.

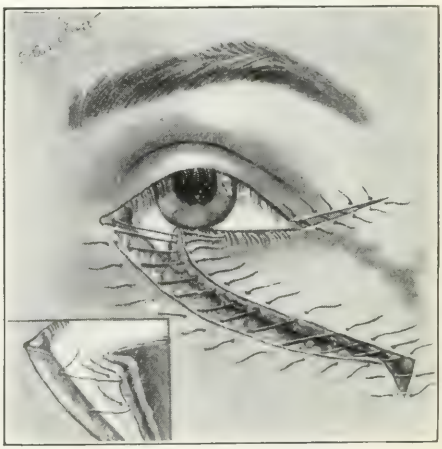

Fig. 6. Case 2. Dissection completed and sutures placed for advancement of lid flap, and repair of conditions shown in Fig. 5. Insert shows a splitting of flap to increase healing surface.

Thus the migration of the eye of the flounder is not simply a curious and isolated fact. It leads us from the evolution of the eye to a study of its involution, and thence to consider even the duty which devolves on every ophthalmologist to interest himself in the problem of preventing at least some of the cases of hereditary blindness.

WAR INJURIES OF THE EYELIDS.

PLASTIC OPERATIONS FOR A FEW TYPES. CASE REPORTS WITH PHOTOGRAPHS AND DRAWINGS.

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Fort McHenry, Md.

At Fort McHenry we have had a large and active service in plastic surgery about the eyes. Much of this has had to do with the lids. We have had large enough series of cases of different types so that we could study methods, and it is my desire to present a few suggestions in regard to the surgical handling of some of the types of lid injury.

1. *Notch of the Eyelid Associated with Laceration of the Tarsus.*—Illustrative of this type of injury, let me cite the history of a case:

McG. received a gunshot wound. Enucleation of the right eye had been performed in France. There was a marked disfigurement of the upper lid in the form of a notch. The tarsus was torn through completely, and imperfect union with scar tissue formation had taken place. A cicatricial band extended upward from the tarsal laceration in the lid substance, and a second band could be felt beneath the skin to the nasal side of the notch and independent of it, attached above to the orbital rim.

Fig. 1 illustrates the outward appearance of the deformity. Operation: The little mass of scar formation in the tarsus

was excised, and the tarsal flaps were trimmed to give accurate apposition. Care was taken to excise fully as much tarsus at the upper margin as at the lower margin in each flap of tarsus. This is important, and even a slight overcorrection of the notch can be encouraged, at the surgeon's discretion, by diverging the tarsal incisions from the lid margin, so as to make the tarsal flaps slightly shorter above than below. The skin and orbicularis were cut so as to make a flap, as shown in Fig. 2.

The little tongue of skin was trimmed enough for adjustment, and above, a small triangular piece of skin was removed, to save puckering. The conjunctiva and tarsal flaps were sutured as illustrated in Fig. 3. A mattress suture was carried through the flaps, as shown in Fig. 2, and tied after passing through a small rubber plate. Sutures were introduced to give good apposition of the skin-flaps (Fig. 4). Dissection of the independent band of scar tissue was made through a separate skin incision (Fig. 4). The lids were then sewed together, so that the lower lid margin would act as a splint for the upper. Care was taken not to tie any of the sutures too tight and so cause sloughing. A rubber tissue dressing was applied. The sutures were all removed in four days.

An important point is that tarsal incisions and skin incisions should never be in the same position, but should be made in such a way that there is overlapping. Thus, what is known in carpentry as "*halving*" is accomplished, and union is assured, even if there is a little sloughing of the skin. Furthermore, recurrence of the notch formation is prevented.

In handling notch cases different short-cut procedures have been tried, but the "halving" method has been the only satisfactory one in my hands.

If necessary, to prevent tension on the wound, especially if the eyeball has not been removed, a canthotomy should be performed, and the branch of the external canthal ligament should be severed to release the tarsus. After healing there is no break in the continuity of the lid margin or in the row of eyelashes.

2. *Laceration of the Lower Lid from the Inner Canthus Downward and Outward.*—This type of deformity is seen in many cases of war injury, as well as in injuries of civil life, and the fact that failure to get proper healing with good results is the rule, and not the exception, is well known. Allow me to speak of an illustrative case and to mention a few points that make for success in the correction of the condition.

S. A. L. received a gunshot wound in action in the Argonne Forest November 1, 1918. This resulted in rupture of the choroid (left eye), a laceration through the canaliculus of the left lower eyelid, and fracture of the left malar bone, with slightly depressed scars in the malar region. The coloboma of the lid is shown in Fig. 5. Two attempts had been made to correct the deformity. A mass of scar tissue was associated with the gap.

In this type of injury it is difficult to get the apex of the lid-flap to adhere accurately in position after operation. Usually it heals in a position too low, and consequently fails to lie back in contact with the globe. For a good corrective result the apex of the lid-flap should be fully up and back in position. Moreover, no new deformity should be added in the process of repair. In some of our cases that have had reparative procedures we have noticed deformity due to differences in the area of the two healing surfaces. In such cases the raw surface of the lid-flap is liable to be more narrow than that of the nasal (stationary) flap. Furthermore, in some cases received at Fort McHenry, where there was incomplete adhesion of the two raw surfaces, it was evident that there had been no repair of the conjunctiva, which was concerned in the injury.

Fig. 5 is from a photograph before operation. No idea can be gained from the photograph of the amount of cicatricial tissue present at the site of the wound. Even on examination of the patient himself one is liable to underestimate the extent of subcutaneous scar tissue formation in such cases. *This cicatricial tissue should be entirely removed,*

even if the sacrifice seems great at the time of operation. There should be no compromise on this point, or failure may result from non-union of the flaps or from breaking down of the tissue.

The incisions shown in Fig. 5 should be long enough to insure the possibility of sufficient advancement of the flap so that the end will fall into position without any tension whatever, after most of the sutures have been introduced.

Suturing.—Suturing should be started at the base of the movable flap and placed in such a way that the interspaces are greater in the stationary skin than in the movable lid-flap. This difference in spacing should be greatest near the base of the flap, and should diminish toward the apex. In other words, traction should be greatest at the base and should diminish toward the apex of the lid-flap, and at the end of the flap there should be none at all.

Anchorage.—Proper anchorage of the angle of the lid-flap backward and upward in a position of slight overcorrection is important. This can be accomplished by carrying the skin sutures through more deeply in the tissues on the nasal side than in the lid-flap, and by anchoring the apex back to the canthal ligament, carrying the angle of the lid-flap as high as possible.

Drainage.—This is advisable in all plastic work of this kind. My preference is to avoid ligatures for bleeding vessels, and to rely on pressure and artery clamps to control hemorrhage during operation. In the tissues about the eyes subcutaneous ligatures of any character are liable to cause trouble either early or late after operation. However, avoidance of ligatures on vessels leaves the possibility of the formation of a hematoma after operation, and this may become infected, and cause the wounds to open. A small gauze drain introduced at operation, and allowed to remain for a few days, is good preparation for such a possible mishap. The drain should be at or near the base of the flap.

Fig. 7. Case 2. Elastic relaxation applied at completion of operation.

Fig. 8. Case 2. Three weeks after operation.

Fig. 9. Case 3. Laceration of lower lid near inner canthus with coloboma and cicatricial ectropion. Fracture of orbital margin.

Fig. 11. Case 3. Three weeks after operation.

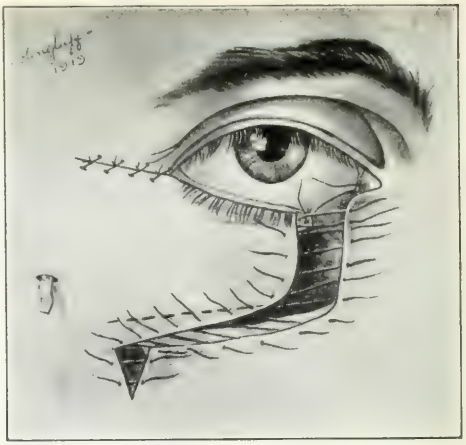

Fig. 10. Case 3. Dissection. Sutures ready to tie. Note dissection at inner canthus, exposed nasal end of tarsus, and beveled incision.

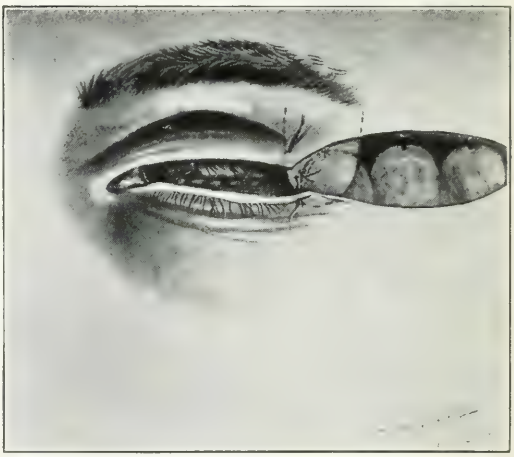

Fig. 12. Case 4. Coloboma at outer canthus, fracture and depressed scar. Dissection has been completed and subcutaneous grafts have been turned into depression.

Fig. 13. Case 4. Cul-de-sac and outer canthus two and a half months after operation.

Splitting the Margin of the Lid-flap.- In operating in this type of injury, the surgeon may be confronted with a discrepancy in the raw areas which must be brought in apposition. The margin of the lid-flap is apt to be too narrow. It is important that apposing raw surfaces should match. A simple and effective scheme is to split the lid-flap at its edge, as shown in the insert in Fig. 6, and thus increase its healing surface enough so that it will cover the apposing healing surface. The conjunctiva should be carefully sutured before the skin sutures are placed in the end of the flap. Fine silk thread should be used in the conjunctiva, and the sutures should be tied toward the eyeball.

Tension of Flaps. -*Effective relaxation* is important. Fig. 7 shows a good method. Strips of adhesive are equipped with small hooks. Ordinary dress hooks, as suggested by Captain C. E. Nutter, are entirely satisfactory. Small perforations are made in the adhesive strips, and the hooks are slipped through; then the adhesive is turned so as to inclose the base of the hooks, which cannot slip through the openings. The adhesive strips are placed so that the proper traction will be produced to give relaxation of the flap. A rubber band is strung between the hooks to produce tension. Elasticity is essential to produce continuous traction, and I do not hesitate to recommend this method highly. The skin sutures should be removed in four days, to prevent the possibility of pus formation about them, and to prevent suture scars, but the relaxation apparatus should be kept on for ten days to two weeks, to assure strong union with the eyelid in the proper position. Fig. 8 illustrates the photographic appearance three weeks after operation.

For suture material in this kind of plastic work linen thread dressed with paraffin and vaselin or with a bees-wax preparation is most satisfactory. It is stout and pleasant to handle, and is not given to absorbing blood and serum to invite infection and pus formations.

In cases with injury to the lower canaliculus and impairment of lacrimal drainage epiphora may be annoying, and removal of the main lobe of the lacrimal gland gives relief. In the case mentioned, and in similar cases, we have practised extirpation of the gland with satisfactory results.

3. *Laceration of Lower Lid Near Inner Canthus with Coloboma and Cicatricial Ectropion.*—In order to bring out two more points in the repair of the type of case just mentioned under the second heading I wish to speak of another case belonging to the same type.

Private T. R. received a gunshot wound, causing a laceration through the lower canaliculus of the right eyelid, a marked ectropion, a large coloboma, and a heavy mat of scar tissue, overlying a fracture of the superior maxillary bone. Fig. 9 is from a photograph taken on the patient's admission to General Hospital No. 2 at Fort McHenry.

The mass of scar tissue was excised, and several small foreign bodies removed. In war wound cases foreign particles are almost always found in the scar tissue, and sequestra are occasionally encountered. A free canthotomy was performed, and an incision was carried upward and outward from the outer canthus.

Fig. 10 shows the lid-flap that was shaped, the drain, and the skin sutures in place. What I want to emphasize here particularly is the advantage that was taken of the fact that a very small area of skin was left uninjured at the inner canthus. This was dissected up carefully and was preserved uninjured. Unless such cases as this have been subjected to operations, usually some such little flap of skin can be seen, and by delicate dissection lifted from its bed. In removing the scar tissue and the skin involved in the cicatrix, care was taken to save a little flap of tarsus. In suturing, this little tarsal flap was slipped behind the little skin-flap, and held there by a mattress suture, tied so as to assure apposition of the raw surfaces, but not too tightly.

Then the end of the tarsus was anchored upward and backward securely by a suture which passed through it and through the canthal ligament. It is safe to tie such a suture snugly. In the healing process in this case there was no slipping of flaps. One can afford to sacrifice healthy skin of the lid when it seems very scarce, in order to get such a little flap of tarsus to help in the "halving" process. I think too much stress cannot be given to this idea.

The other point which I should like to make here is in regard to the value of a beveled incision such as was used in part of the dissection in this case, and shown in Fig. 10. After all scar tissue had been dissected out an incision was carried downward and outward, and a triangle was removed from the lower flap at the temporal end of this incision. Obviously, this was done to allow advancement of the lid-flap for adjustment. In making this deep downward and outward incision it was carved in a slanting (beveled) fashion instead of directly backward at right angles to the skin surface. Two important things are thereby accomplished: First, permanent depression of the scar is largely avoided. Second, a larger healing area is afforded the flaps.

Fig. 11 is a photograph taken about three weeks after operation to show the lower eyelid in place.

4. *Coloboma at the Outer Canthus.*—This is a less common war injury than those already spoken of.

Corporal F. G. was wounded by high explosive in action on September 21, 1918, at St. Mihiel. Fragments produced rupture of the left eye. Enucleation was performed. Fracture of the left malar bone resulted, with wounds of the soft parts in the malar region. On admission to General Hospital No. 2, Fort McHenry, the left eyelids were widely separated at the outer canthus. The outer part of the lower lid was everted, and a heavy depressed scar extended back one and one-half inches from the outer end of the eyelids.

Operation: Ether, March 22, 1919. The mass of scar tissue was largely excised, and the skin widely undermined

in both upper and lower flaps. Subcutaneous grafts were everted on pedicles and sutured in position to fill in the depressed area. A subcutaneous graft was turned on the external orbital margin, and to this the conjunctiva was sewed. Another graft was turned over on the first, overlapping it in such a way that the nasal margin of the flap would shelve over the graft underneath. To the second graft the skin was sutured at the temporal ends of tarsi to make an outer canthus. In this way the culdesac was made behind the newly formed canthus. The skin-flaps in the malotemporal region were brought together by silk sutures. The handling of this case illustrates an important means of filling in depressions and reconstructing the outer canthus.

In this case there were three important objects to be attained. One was to fill in the unsightly depression behind the orbital margin. A second was to form a permanent culdesac behind the outer canthal region. The third was to make a sightly outer canthus. In this case, to attain the first object, subcutaneous pedunculated grafts were used as filling. These grafts consisted of fascia, fat, and muscular tissue, and were cut so that their pedunculated bases were toward the depressed area, and with the attached bases as hinges simply turned upside down into the depression and sutured in place (a single suture is enough for each flap). In order to get the proper adjustment of tissues for the formation of the canthus and the culdesac which must reach behind the tissues at the canthus, care was taken in the placing of overlapping grafts to the nasal margins of which first the conjunctiva and then the skin were anchored. In Fig. 12 an effort has been made to show the arrangement of the subcutaneous flaps and the manner in which the outer culdesac and outer canthus were constructed.

In using subcutaneous grafts with pedicles it is important that the grafts should not be too large. It is better to use a series of small grafts than one large one, as there is much less reaction following operation, less danger of their break-

ing down, and, most important of all, less deformity occasioned by operation. It is necessary to overcorrect slightly, in filling in depressions with subcutaneous grafts, as well as in the use of free grafts. Probably the depression in this case could have been filled in satisfactorily by the use of fascia lata, but free grafts would have made unsatisfactory anchors for the conjunctival and skin tissues at the outer canthus.

Fig. 12 shows the operative field after the mass of scar tissue had been removed and the skin trimmed, and with the pedunculated grafts turned into the depressed area.

Fig. 13 illustrates the appearance of the outer canthus two and one-half months after operation.

INTRODUCTORY REMARKS.

EXHIBITION OF FILM, "FIT TO FLY."

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The part that aviation was to play in the war was recognized very early. The Surgeon General placed the medical problems in the hands of the Chief Surgeon. Examining units were formed all over the United States to examine candidates for the Aviation Corps.

It was soon found that even among men who seemed equally fit some proved to be good fliers, others poor. This meant special medical problems. The Medical Research Board was the outcome. The Laboratory was its workshop. The medical problems of aviation fell, by process of natural evolution, into the following groups:

(1) Selection of fliers.
(2) Classification of fliers for the different types of work.
(3) Care of fliers in training and in combat.

In addition to the physical and psychological tests, it was felt that the close association with the fliers, as in the case of the flight surgeons, gave great information concerning the flying and fighting spirit of the pilots.

These pictures are the result of the work through the office of the Chief Surgeon. Many forms of apparatus and tests have been improved since these pictures were taken, while to some of the physiological changes noted in the early period of the work new interpretations were given later on. This morning, in a book on aviation by Lawrence A. T. Driggs, a great authority upon the subject, I came upon the following illuminating sentence: "While our air-fighters are doing no more than their duty, and no more than their comrades in the trenches or on the sea, yet this duty requires from them far greater risks, more specialized training, and more particular fitness, both mental and physical, than is required of their brothers in the other arms of warfare."

This film, or rather series of films, illustrated the relation of ophthalmology and even of otology to air service. They showed the various examinations to which the aviator was subjected not only by routine methods, but to classify him, if possible, according to his ability to fly at different heights.

As the amount of oxygen in the air decreases by a definite ratio in proportion to the elevation, this lack of oxygen can be produced artificially by exhausting the air from tanks built for that purpose, or by the so-called re-breathing apparatus. Pictures of both these pieces of apparatus were shown, and the effects of the lack of oxygen on the subject were illustrated in the moving pictures. In like manner other appliances and their uses were shown in detail. Most of these were examples of the work done at the Medical Research Laboratory at Mineola.

Fig. 1.—Rounded scar at nasal margin right eyebrow, loss of lower right lid tissue, corneal haze. Left lower lid absence of cilia outer half.

Fig. 2. Illustrating Dr. A. J. Bedell's article on Multiple Vaccination of the Eyelids. Symblepharon before operation.

MULTIPLE VACCINATION OF THE EYELIDS.

ARTHUR J. BEDELL, M.D., F.A.C.S.,
Albany, N. Y.

There are two reasons for presenting this case to you—one, that as far as the records show no such report has been given this society, and the other, that although vaccination is common, there are noted comparatively few eye complications.

The infrequency of eye involvement following vaccination is very striking when we consider the number of vaccinations, the doubtful handling that many receive, and the ease with which infection may be transferred. This ease of transference by slight contact is detailed by Clarke; four members of a family slept in the bed previously occupied by a recently vaccinated child; all but one developed vaccinia. In Schapringer's case, a physician patted the face of his patient, who later developed ocular vaccinia.

The severity of complications varies—the loss of an eye has been noted many times. One eye was destroyed in cases reported by Calhoun, Betti, Schwabe, and Doehler; both eyes by Tilly in a case with pemphigus. Corneal involvement with opacities interfering markedly with vision is described by Morax, Syndacher, Schmitz, Knaggs, and Block. Lid deformities are numerous, from the pale areas without cilia to adhesions of lid or lids to the globe. Mark reports a symblepharon, and both he and Thompson ankyloblepharon.

A review of the literature shows that although the majority of the cases have been mild, nevertheless very serious complications may follow this seemingly simple lesion, and

further that the severity of eye change does not always have a direct relation to the patient's previous history of successful or unsuccessful vaccination.

When seven years old, our patient was unsuccessfully vaccinated. A year later the result was the same.

Mrs. A. H., married, aged thirty-one years, was brought by her physician, Dr. Walter A. Reynolds, to the office September 16, 1918, with a history of having had hay fever since the early part of July, with much irritation of her eyes and intense itching.

On August 27th her young son was vaccinated on the left arm. The patient had been caring for his wound, but had always carefully washed her hands immediately after the dressing, with the one exception of the afternoon of September 8th, when she is positive that she rubbed her right eye, without washing her hands, immediately after dressing the boy's arm. On September 12th, when she awoke in the morning, the right eye was swollen and the lids closed, which, as she says, "was like a watery blister and the pupil lay back in it." Ice compresses were used constantly. The edema entirely disappeared, although the eye remained red and watery. The swelling, which again returned on the fifteenth, did not subside under ice, and it was impossible for the patient to even forcibly open her lids. Between September 12th and 15th she noticed an enlargement in front of her right ear. Her physician first saw her on the fifteenth, and, as the treatment had no effect on the local swelling, brought her to me the next day.

Examination.—September 16, 1918: Right eye: The middle two-thirds of the lower lid margin was rough, with an ulcerating surface including the loss of the cilia, for an area of about 10 x 4 mm. The margins of the ulcer were not undermined, although its base was covered with a tenacious, dirty-gray, and somewhat adherent membrane. Surrounding the ulcer was a definite zone of infiltration and the entire lid was greatly swollen and congested. The upper lid was markedly reddened. Congestion of the bulbar and palpebral conjunctiva with moderate blepharospasm and photophobia. A slightly stringy, mucopurulent secretion collected in the

lower culdesac. Cornea clear; pupil 4 mm., regular and active. Both pre-auricular and post-auricular glands were decidedly swollen and tender. The left eye was negative.

Two days later, on the 18th, a definite 6 mm. vesicle, the scar of which is evident in the photograph, was seen almost at the nasal margin of her right eyebrow. The right eye showed a greater loss of lower lid tissue, with two distinct macerating areas on the upper lid margin. These were watery gray, degenerating vesicles. The swelling of the entire right side of the face was considerable, but it was possible to open the lids without the use of elevators. The cornea remained clear. There was very slight conjunctival secretion, although the grayish membrane remained adherent to the lower ulcer and the induration persisted.

The left eyelids were affected; a small 7 mm. vesicle on the upper lid, 9 mm. from the external canthus, and one on the lower lid, involving practically the outer half of the lid margin, so that the left eyelids presented the picture of the right when seen two days before.

From the first the patient complained of intense ocular pain followed by marked prostration, which confined her to bed from September 20th to 30th. The temperature was but slightly elevated until the morning of September 21st, when it was 101° F. with 96 pulse, and by evening reached the highest point, 102° F.

The entire right side of the face and neck was congested with intense edema, and a profuse serous discharge from the eye was present. The lower lid was so tense that the large ulcerating surface, now 25 x 10 mm., was in contact with the cornea, producing a slight superficial haze.

The left lids were so swollen as to be blanched by pressure, while the two ulcer areas were less macerated.

On September 26th, the tenth day of observation, the firm swelling of the right temporal and malar region was so painful that two incisions, 12 mm. long, were made, one above and the other below the external canthus. The profuse serous flow decidedly relieved the condition, although lid elevators were necessary, even partly, to expose the cornea.

The vesicle in the right eyebrow was beginning to heal, and the ulcers on the left eyelids were drying, with marked decrease of the surrounding congestion.

Two days later the twelfth day the right corneal opacity was greater, with interstitial infiltration. The swelling of the lids was slightly less. The left eyelids were practically healed, with the exception of a small area without epithelium on the lower.

On September 30th the fourteenth day the cornea perforated, with a minute opening 3 mm. below the apex. From that time the right eye improved rapidly. The swelling was greatly reduced each day, so that lid elevators were no longer needed to view the cornea. The glands were no longer palpable, and the pain had disappeared.

By October 1st a symblepharon of practically the entire lower lid and eyeball gave the patient much discomfort by lacrimation and photophobia. The annoyance steadily lessened, and the anterior chamber quickly reformed without iris adhesion.

On November 9th vision of the right eye was 20/200, with a diffuse corneal haze of the inferior central portion. The lower palpebral conjunctiva still remained swollen. The scars on the eyebrow and on the upper and lower left lids were smooth, but still congested. The left eye: Pupil 4 mm., regular, active; disc clear; vision 20/15, and, except for the two areas where the cilia are absent, shows no ill effect.

On February 5, 1919, the patient was operated upon under ether. The right lower culdesac was dissected to the inferior orbital margin, two large flaps of rabbits' conjunctiva were sutured one to globe and the other to the lid. The latter held deeply in the culdesac by sutures through inferior orbital margin periosteum and tied on the cheek. Healing was uneventful, and the result a freely movable, comfortable eye.

On May 26th the patient's vision of the right eye was 20/30(?), with correction for compound hyperopic astigmatism, full 20/30 and Jaeger 1. There was slight conjunctival injection with a tendency for the few remaining cilia at the inner canthus of the right lower lid to irritate the cornea.

The differential diagnosis was of considerable interest at first and later. The immediate primary thought was an initial lesion or diphtheritic conjunctivitis, the former because of the firm induration about the ulcer and the latter

because of the adherent membrane. To appreciate the making of a correct diagnosis it must be remembered that neither the detailed history above recited was then obtained nor was there anything to suggest the later proved cause.

The following conditions have been confusing to others having similar cases: Diphtheria, herpes, pemphigus, hard chancre, soft chancre, malignant pustule, tuberculous conjunctivitis, erysipelas, trachoma, and gonorrheal ophthalmia.

Our diagnosis was made by the history and typical vesicles that secondarily involved the eyebrow and left lids. Blood reaction being normal, conjunctival smear not presenting Löffler bacillus, Ducrey bacillus, Neisser organism, anthrax, or streptococcus, many of the confusing diagnoses were immediately excluded and our attention drawn to clinical proof of our diagnosis. As you all know, Guarnieri claimed that vaccine of the cornea produced a definite cell grouping, but unfortunately this was disproved by other observers, including Wasielewski. The only other process was to vaccinate a calf's udder and note the lesion. We were ready to do this, but the patient developed the typical diagnostic vesicles, making further research unnecessary.

To summarize this case, the patient, three days after known contact, developed her first symptom; having no immunity, the infection was unusually severe, and the individual lesion, altered by the tears, was masked. Ten days after known contact the other lesions developed and they passed through the usual stages of vaccination—vesiculation with congestion and gradual drying until finally a smooth white scar remained. The corneal pressure change, extremely alarming at one time, was finally cured, with excellent result, and the lid and globe adhesions mechanically separated.

The appended bibliography, complete as far as it is possible to make it, with the books in this country, embraces all cases since the introduction of vaccination. Therefore

this seems to be the ninety-third case of ocular change following vaccination.

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DISCUSSION.

DR. LEWIS S. TAYLOR, Wilkes-Barre: It is not surprising to me that Dr. Bedell should have had a case of this sort to report. The wonder is that there have been so few reported in the past, when we consider the lack of care given by many people to the vaccinated arm, and the liability of children to scratch the sore and then rub their eyes with the unwashed hands. In a somewhat large experience, extending over many years, I have seen but one case of this trouble. A number of years ago I was called in consultation by one of my colleagues, Dr. Buckman, to see a child of about three years of age, with what we believed to be a genuine case of re-vaccination. She had a much swollen and irritated lower lid, with some discharge, and inflammation involving the lower part of the cornea. She was sleeping in the same bed with her sister, and both children had been vaccinated some time before. The girl, either from her own sore or from that of her sister, had been vaccinated on the lower eyelid, the general condition being the same as Dr. Bedell has described. The case ran a typical course, and the child recovered without any ill effects. I thought of reporting this case at the time, but as I had only the one patient, I refrained. If this condition had been in an adult we might have thought at once of an initial lesion, as it resembled a chancre, but there was the history of vaccination, with the still unrecovered sore, and there was no doubt about the diagnosis.

DR. ARTHUR J. BEDELL, Albany: The photographs, taken previous to the late operation, simply show the loss of tissue and the symblepharon.

A CASE OF KERATITIS PROFUNDA (OR DISCIFORMIS?) WITH MICROSCOPIC EXAMINATION.*

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Boston.

Although it is possibly somewhat uncertain whether the case I have to report should be classified as one of keratitis profunda or of keratitis disciformis, our knowledge regarding the true nature of either of these conditions is so indefinite that the histologic findings in my case would seem to be of considerable importance. The case occurred at the Massachusetts Charitable Eye and Ear Infirmary on the service of Dr. F. M. Spalding, to whom I am indebted for the privilege of reporting its clinical features.

Case.—Benjamin H. N., aged sixty-five, stableman. Admitted to the Massachusetts Charitable Eye and Ear Infirmary January 2, 1915. The patient states that his left eye has been affected for the past three weeks. The vision has become blurred, and the eye has felt irritated, but there has been no actual pain.

Examination.—Right eye normal, vision 20/30, tension 17 mm. (Schiötz). The left eye is considerably congested. The cornea is markedly hypesthetic, has a distinctly grayish hazy appearance, with general unevenness of the surface, probably due to edema, but it does not stain with fluorescin. The anterior chamber is normal in depth. The pupil, normal in size, reacts poorly to light. The iris markings are slightly blurred. The corneal condition obscures view of the fundus. Tension 35 mm. (Schiötz); vision, fingers at $1\frac{1}{2}$ feet. Solution of pilocarpin nitrate 1 per cent. ordered to be instilled three times daily.

* From the Massachusetts Charitable Eye and Ear Infirmary.

FIG. 1. Median vertical section of cornea showing half of affected area. (The other half presented a similar appearance.) The epithelium is intact but altered. The anterior layers of the central portion of the cornea are devoid of nuclei. In front of Descemet's membrane the corneal corpuscles have actively proliferated, forming a layer which rapidly widens out and disappears at the periphery. In the middle layers of the cornea some of the corpuscles show various stages of necrosis, others active proliferation. There is no infiltration with leucocytes. The endothelium is absent and the posterior surface of the cornea is coated with fibrin and leucocytes. Hæmatoxylin and eosin. Photo × 41.

FIG. 2. Section of central portion of affected area of cornea under higher magnification. Hæmatoxylin and eosin. Photo × 150.

January 10th: Left eye painful and more congested. Pupil contracted and irregular. There appear to be some deposits on the posterior surface of cornea.

January 11th: Atropin sulphate 1 per cent. substituted for pilocarpin.

January 13th: Pupil dilated and irregular from posterior synechiæ.

January 17th: Tension lower. Pupil half dilated. Deposits on posterior surface of cornea persist.

January 24th: Less pain. Cornea still quite hazy.

January 31st: Some blebs on cornea as in bulbous keratitis. Tension only slightly elevated. Some pain at times.

February 7th: Very little pain. Cornea roughened and hazy. Moderate congestion.

February 21st: Tension normal.

February 25th: There are two spots in upper part of cornea that stain with fluorescin. Very little pain. Tension normal.

February 28th: Some superficial vascularization of cornea above. Pupil moderately dilated.

March 21st: Eye more congested. Cornea very hazy. Enucleation advised.

March 22d: Enucleation of left eye under local anesthesia by Dr. Lancaster, eleven weeks after onset of keratitis.

PATHOLOGIC EXAMINATION.

(3-2789.) Fixation in an aqueous solution containing formalin 10 per cent., alcohol 54 per cent.

Macroscopically.—The globe is normal in size and shape. The cornea is clouded by the method of fixation so that no details can be made out within it. Its surface is smooth and is covered with epithelium. There is a vascularized pannus all around, most marked above. The anterior chamber is slightly shallow, and contains a delicate serous coagulum. The lens is *in situ*. The filtration angle is everywhere free. The pupil is 3 mm. wide, and its margin is firmly adherent to the lens. The vitreous is normal. The retina and choroid are *in situ* and apparently normal. The disk is not swollen or noticeably cupped.

Histologic Examination.—Fixation as noted above. Meridional vertical sections through most of the central portions

of the cornea, and plane sections through the remaining central portion. Longitudinal sections through the optic nerve nearly to the central vessels; serial cross-sections of the remainder of the nerve. Staining in hematoxylin and eosin and in a variety of other stains.

The most marked corneal changes involve a central area about 4.5 mm. in diameter. (See Fig. 1.) Here, in the anterior third of the corneal stroma, the lamellæ have become slightly hyaline in appearance and have lost their distinct outlines, while the corneal corpuscles have completely disappeared. In fact, no cells of any kind are present here. (See Fig. 2.) Posteriorly, the corpuscles become visible in small numbers, many of them, however, showing chromatolysis, pyknosis, or fragmentation of their nuclei, and others active proliferation. Just in front of Descemet's membrane, in a sharply defined layer about one-seventh the thickness of the cornea, the corneal corpuscles are greatly increased in number, their nuclei are rich in chromatin, and many of them show various stages of amitosis or mitosis. At the periphery of the central area this layer of proliferating corneal corpuscles extends away from Descemet's membrane and rapidly becomes broadened out and disappears. The corneal stroma shows no vascularization, and is almost free from leukocytic infiltration throughout, except near the limbus, where there is slight infiltration with pus-cells.

In this central portion the cornea is reduced to about two-thirds its normal thickness, probably owing to shrinkage and compression of the injured tissue resulting from the action of the fixing fluid employed. Bowman's membrane is everywhere intact. The epithelium is normal at the periphery of the cornea, but over the central portion it is greatly altered. Here it is thinned, due to changes affecting the basal cells, the squamous surface layers being intact. The basal cells are shrunken and distorted, and their nuclei are often pyknotic. Many of the pyknotic nuclei are stretched out into irregular fantastic shapes. These changes are best seen in plane sections. In places there are small cystic spaces beneath the intact surface layers, containing discrete altered basal cells that have been cast off from Bowman's membrane.

Descemet's membrane is also everywhere intact. The endothelium is completely absent behind the central portion

of the cornea, a stretch of 1 mm. of it remaining at the periphery below, and 4 mm. above. Behind the central area there is a layer of fibrin and leukocytes, about 0.04 mm. thick and 4.5 mm. in extent. Immediately in contact with Descemet's membrane the leukocytes consist almost exclusively of pus-cells; the other cells enmeshed in the fibrin are chiefly endothelial cells, many of them containing pigment. Occasionally one of the endothelial cells is multinucleated. Many fibroblasts are also seen, indicating that organization has begun. Toward the periphery the layer of fibrin ends rather abruptly, but considerable numbers of pus-cells and small and large lymphocytes are adherent to the cornea all the way to the filtration angle. About 5 per cent. of the polynuclear leukocytes are eosinophiles.

In addition to the large central corneal lesion just described, two smaller spots, evidently of the same general nature, are encountered. The spots are similar in character, but the sections pass through the center of only one of them. The latter is about 0.75 mm. in diameter. Within it the corneal corpuscles beneath Bowman's membrane for a depth of three or four lamellæ show marked pyknosis and fragmentation, while those still deeper are greatly increased in number and their nuclei show various stages of amitosis and budding. In this vicinity the stroma shows a slight infiltration with pus-cells. Over the center of this spot the epithelium is markedly altered. The basal cells have disappeared as a definite layer, and the surface layers are lifted up, leaving a cystic space filled with discrete cells. The latter have only a small amount of cytoplasm, possess small nuclei of various sizes, and seem to have been derived from basal cells that have been cast off from Bowman's membrane. Intermingled with these cells there are also a few pus-cells.

The tissue of the limbus is highly congested and greatly thickened by infiltration with chronic inflammatory cells, chiefly plasma cells. Extending between the epithelium and Bowman's membrane from above for 2.75 mm. there is a pannus somewhat similar in appearance to a pannus degenerativus. This is actively growing and is richly infiltrated with chronic inflammatory cells. A similar pannus is beginning below. A few vessels are just beginning to push their way from the sclera into the deeper layers of the cornea.

The filtration angle is nowhere blocked by the root of the iris. Below it is filled with leukocytes up to the level of the end of Descemet's membrane, and also contains a small amount of fibrin. Pus-cells predominate here, but there are also many plasma cells, lymphocytes, and a few endothelial cells. The spaces of Fontana are filled with similar cells. A few new-formed capillaries are making their way over the surface of the ligament, some of them beginning to extend over the posterior surface of Descemet's membrane. The serum filling the anterior chamber contains scattered leukocytes—about six to twelve to the high power field.

The iris is considerably infiltrated with chronic inflammatory cells, chiefly lymphocytes, but is not highly congested. The infiltration is greatest in the region of the sphincter, where it tends to assume a nodular character. Along the anterior surface of the iris are numerous leukocytes, mostly lymphocytes, but almost no fibrin. There is annular posterior synechia 1 mm. wide. From the pupillary margin there extends a thin fibrous membrane over the surface of the lens, blocking the pupil. Over the central portion of this membrane there is a layer of fibrin in which a few leukocytes are enmeshed.

The ciliary body is almost normal, showing only a slight leukocytic infiltration. The retina and choroid are normal. The optic disc is possibly very slightly cupped. The central vessels, cut in serial cross-sections, are normal. The lens is practically normal, showing only slight cataractous changes at its periphery.

Bacteriologic Examination.—Sections stained by the Gram method, the method for tubercle bacilli, and in carbolthionin, show no microörganisms in the cornea or elsewhere.

REMARKS.

This case was not seen by me clinically, and the clinical notes upon it were made by a house surgeon unfamiliar, naturally enough, with such rare conditions as keratitis disciformis and keratitis profunda. The clinical description, therefore, is not sufficiently detailed for a diagnosis to be made from it alone, but interpreted and amplified in the

light of the microscopic findings it shows that clinically the cornea displayed a grayish circular opacity 4.5 mm. in diameter. Over this the epithelium was intact, but presented a marked stippling of its surface, and on one occasion, vesicles. The margin of the opacity must not have been sharply defined, but was intensified by the zone of proliferating corneal corpuscles surrounding the main opacity. It is doubtful that this was sufficiently conspicuous clinically to form the intensified border described by Fuchs as characteristic of disciform keratitis. The thick layer of fibrin and leukocytes, however, on the posterior surface of the cornea had an extremely sharp peripheral outline, and may well have given a disciform appearance to the whole opacity as seen clinically. In addition to the central opacity there were two outlying superficial punctate spots, both of which were also seen microscopically. Both clinically and microscopically there was noted severe iritis with posterior synechia and deposits on Descemet's membrane.

From these facts it is obvious that this case was either one of keratitis profunda or of keratitis disciformis.

The opacity of the cornea was, no doubt, primarily due to alteration in the anterior layers of the cornea, manifested microscopically by slight hyaline change of the lamellæ and destruction of the corneal corpuscles. Later it was greatly increased by the layer of proliferating corneal corpuscles in front of Descemet's membrane and by the thick layer of fibrin and leukocytes deposited on the back of the cornea. The changes in the epithelium in this case were most striking. Just how much importance to attach to them it is difficult to determine, since the eye was removed under local anesthesia and the cornea was exposed to drying and the action of cocain for an unusual length of time. The distortion of the nuclei was almost certainly due chiefly to this cause. The other changes, however, were probably not artefact because they existed only over the affected portions of the

stroma, namely, over the central area and over the small punctate spots at the periphery. Moreover, I have never seen such changes in any other eye removed under local anesthesia.

In the literature no case diagnosed as keratitis profunda, and only two cases clinically diagnosed as disciform keratitis, have been examined microscopically, one reported by Hadano[1] the other by Meller.[2] Hadano examined only a piece of tissue removed from the cornea by means of a sharp spoon, while Meller examined the entire eye. The findings in these two cases were so different that it is almost, if not quite, impossible to believe that the two cases represented similar conditions. Thus Hadano found that the small piece of tissue removed by him (he does not mention its exact size) consisted of a swollen mass of wavy interlacing bundles in which there was complete absence of inflammatory infiltration or tissue proliferation. Only a few nuclei were to be seen, and in the central area almost no nuclei were present. On the other hand, Meller found intense cellular infiltration with necrosis of the infiltrate and loss of corneal substance.

In my case the microscopic findings were in accord with those of Hadano. The additional features found by me could not, of course, have been seen by Hadano, because he did not remove a sufficient thickness of corneal tissue to reveal them, while the appearance of wavy bundles described by him is no doubt explained by the traumatism to which the tissue was necessarily subjected during its removal.

The possibility may suggest itself that the changes present in the cornea in my case existed in Meller's case but were masked by a secondary infection. Careful examination, however, of sections from Meller's case, which were kindly sent to me by Professor Fuchs several years ago, excludes this possibility, for in these sections there is no trace of the hyaline condition of the corneal stroma, nor of the layer of proliferating corneal corpuscles which in my case walled off the cen-

tral area from behind and also formed a peripheral zone around it.

As pointed out, my case was certainly one of keratitis profunda or disciformis. Meller's case was just as certainly not one of keratitis profunda, for the great density of the corneal infiltration, as well as the relatively extensive loss of corneal substance, excludes this possibility. If, therefore, we assume that disciform keratitis is a distinct entity, and that Meller's case was a true case of this condition, we must conclude that my case and that of Hadano were cases of keratitis profunda. I am, however, not prepared to make either one of these assumptions.

As a matter of fact I am convinced that the cases of disciform keratitis described in the literature do not represent a single condition. Disciform opacity of the cornea may arise from a variety of causes. As is well known, it may occur in hereditary syphilis, where it probably is due to a metastatic infection of the cornea with spirochætes; it may occur as a type of ulcus serpens, it may result from infection with vaccine virus, as pointed out by Schirmer,[3] it may occur in non-gonorrheal ophthalmia neonatorum due to infection with the streptococcus mucosus, as I have myself observed. Probably it may occur as a form of tuberculosis of the cornea, as suggested by Weeks,[4] and as a result of unknown infections. Finally, it may occur as a complication of herpes corneæ or as a result of trauma, in which cases it is probably neuropathic in origin as maintained by Peters, although Fuchs's view that here also it is due to some unknown infection has not been excluded.

Possibly the cases of keratitis disciformis originally described by Fuchs did comprise an entity, but his clinical description is not sufficiently exact, and probably no description based upon clinical appearances could be sufficiently exact, to enable other observers to identify the condition with certainty. Moreover, such cases are seen by any one

observer at such long intervals that it is unlikely that the clinical picture could often be carried in mind from one case to another. In the clinical description of his case Meller states that after a time the infiltrate presented a sharply defined margin, but he does not mention here the intensified border described by Fuchs as characteristic of disciform keratitis. He does, however, attempt to reconstruct the clinical appearance from his microscopic findings, but in my opinion he fails to do so successfully. One of the sections of his case in my possession passes near the middle of the infiltrate, yet it fails to show anything which would give the appearance of an intensified border. His illustrations likewise fail to do so. In two other ways also his case did not conform to Fuchs's description, namely, in that the density of the infiltrate was unduly great for the small size of the latter and in that the loss of substance was relatively large. For, from measurements made from the section referred to, and from the illustrations of Meller's case, I find that the infiltrate was only 2 mm. in diameter and the loss of substance involved half of this area. Owing to the necrosis of the infiltrate Meller was unable to determine the nature of the cells comprising it. It seems to me, however, that I can identify many of the cells as endothelial phagocytes and to determine definitely, at least, that the infiltrate does not consist chiefly of pus-cells. This is substantiated by the fact that almost no pus-cells are approaching it from the periphery. From the foregoing considerations I conclude that Meller's case, although not one of keratitis profunda, was not a typical case of disciform keratitis as described by Fuchs, and that it was not due to tuberculosis or to vaccine virus, but probably to infection of the cornea with some unidentified non-pyogenic microörganism.

The term keratitis profunda has been used in a general way for many years to describe various forms of deep-seated keratitis, including that of hereditary syphilis, but so far as I can

ascertain Fuchs was the first to restrict its use to a distinct clinical entity. In his latest text-book (Duane's translation) he makes the following statement in regard to the differentiation of this condition from keratitis disciformis: "Keratitis disciformis has a certain resemblance to keratitis profunda, in which also a deep-seated gray, non-ulcerating cloudiness develops in the center of the cornea. But this is composed of gray striæ and specks and merges gradually into the transparent cornea. In keratitis disciformis, on the contrary, the opacity appears uniformly gray and only on strong magnification is resolved into very minute, clear-cut, white, closely packed dots; moreover, it is very sharply demarcated from the healthy cornea by the gray circular line along its border."

Taken in connection with his detailed description of the two conditions, it seems to me that the points mentioned by Fuchs are not always sufficiently definite, and I therefore concur in the view of v. Hippel[5] that it is not always possible to differentiate the two conditions. In other words, I believe there are cases which present the essential clinical features of disciform keratitis, but which are really of the same nature as keratitis profunda, and it is to this class of cases to which I believe my case and that of Hadano belong. This view harmonizes with the following statement made by me ten years ago:[6] "The facts that both keratitis profunda and keratitis disciformis occur most commonly after herpes zoster or trauma, that both may be associated with corneal hypesthesia and show outlying superficial punctate spots, impel me to believe that both conditions are essentially neuropathic, the minor differences between them being dependent on differences in the intensity of the nerve irritation."

The question now arises as to the indications the histologic findings in the present case offer in regard to the cause of the condition, and as to whether or not these findings support the clinical evidence that keratitis profunda is neuropathic in origin. In the first place it is obvious that the central corneal

lesion is due to some diffusible toxic substance arising in the anterior layers of the cornea. This is evident from the fact that the corneal corpuscles have been completely destroyed in the anterior third of the cornea and are progressively less injured from before backward, while next to the membrane of Descemet and at the periphery they have been stimulated by the weakened toxin into active proliferation. Likewise, the corneal lamellæ are most affected anteriorly. That this toxin was of infectious origin is highly improbable. For it seems impossible for organisms to have existed in the cornea for eleven weeks without causing leukocytic infiltration of any kind in the affected area. It is true that highly virulent organisms often produce toxins of such intensity that the latter prevent leukocytes from reaching the site of infection, but in such instances the area is always surrounded by a zone of leukocytes and the infected tissue undergoes necrosis and breaks down. In the present case the corneal corpuscles were destroyed in the affected area, but the stroma was only slightly injured, while the cellular infiltration even of the surrounding cornea was insignificant.

On the other hand, the histologic findings in the present case are in perfect accord with the theory of neuropathic keratitis advanced by me in 1909, and again in 1911.[7] According to this theory, as a result of an irritative lesion in the Gasserian or possibly the ciliary ganglion, impulses are sent backward to the nerve terminals in the cornea where they produce electrolytic changes leading to the formation of toxic substances. The latter then give rise to corneal lesions, chiefly superficial, which vary in character according to the intensity and duration of the nerve lesion and the distribution in the cornea of the nerves corresponding to it. Thus a diffuse lesion in the ganglion involving the nerve supply of the central portion of the cornea would give rise to toxic substances at or near the surface of the cornea which in diffusing backward would produce the changes described.

The associated iritis could be explained either by the action of these toxins on the iris, or by a simultaneous involvement of the nerves of the iris. The deposit of fibrin and leukocytes on the posterior surface of the cornea is easily explained by the destruction of the endothelium by the toxins diffusing through the cornea, just as are explained the mural thrombi that are formed in veins when the endothelium is injured. Had it existed sufficiently long, no doubt it would have undergone complete organization.

The only previous case of neuropathic keratitis of any kind, uncomplicated by infection, in which the entire eye was examined microscopically, was the case of superficial punctate keratitis reported by me in 1911.[7] The punctate spots in this case were situated just beneath Bowman's membrane, and showed necrosis of the corneal corpuscles, as in the lesions of the present case, but in addition were densely infiltrated with polynuclear leukocytes also in various stages of necrosis. The corneal lamellæ were only slightly injured and there was some proliferation of corneal corpuscles at the periphery of the spots. In both cases the epithelium over the lesions was altered but not destroyed. Aside from differences in size, therefore, the only important difference between the corneal lesions in these two cases consisted in the far greater leukocytic infiltration of the lesions in the earlier case. Three possible explanations for this difference suggest themselves: (*a*) That the leukocytes of the patient in the present case were less sensitive to the chemotactic influence of the toxic substances diffused from the cornea, although in both cases these toxic substances were the same in kind. (*b*) That in the first case the toxic substances were produced more rapidly and hence were more concentrated in their action. This is in accord with the fact that at the time of enucleation the duration of the lesions in the first case was about three weeks, in the present case, eleven weeks. (*c*) That early injury to the endothelium in the present case caused the dif-

fusion of the toxins to take place chiefly into the anterior chamber. This is in accord with the fact that an abundance of polynuclear leukocytes were enmeshed in the fibrin on the posterior surface of the cornea.

Assuming that the present case was one of keratitis profunda, it is obvious from the microscopic findings that this term is misleading. For, while the deeply seated changes in this form of keratitis are clinically the most conspicuous, it is obvious that the toxic substances which cause them arise at or near the surface of the cornea.

CONCLUSIONS.

Disciform keratitis may be produced by a variety of causes, and from an etiologic standpoint is therefore not an entity.

Certain cases of disciform keratitis are of the same nature as keratitis profunda.

The corneal changes in keratitis profunda are due to the action of diffusible toxic substances arising near the anterior surface. The changes consist in alteration of the epithelium, destruction of the corneal corpuscles, and injury to the stroma in the anterior layers of the cornea, and proliferation of the corneal corpuscles behind and around the injured area. In addition to this, there is injury to, or destruction, of the endothelium, and in severe cases deposition of fibrin and leukocytes on Descemet's membrane behind the affected area. Leukocytic infiltration of the corneal stroma is conspicuously absent.

The microscopic findings in the present case strongly indicate a neuropathic origin for keratitis profunda.

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DISCUSSION.

DR. WILLIAM ZENTMAYER, Philadelphia: Dr. Verhoeff has stated that his is the first case of disciform keratitis to be examined histologically. My recollection is that in the *American Journal of Ophthalmology*, about a year ago, there appeared an abstract by Blaauw, of a paper by Wagner, a Dutch ophthalmologist, in which was reported a case that had been studied both histologically and experimentally. As I recall it there was a secondary infection and the early and characteristic changes could not be determined, but the experimental work which consisted in the inoculation of rabbit's eyes showed very much the same changes on the posterior surface of the cornea, as in Dr. Verhoeff's case.

DR. E. V. L. BROWN, Chicago: The process here may be upon a neuropathic basis, as contended for by Dr. Verhoeff, but it recalls to me the condition found in ring-abscess, namely, a central wedge of necrotic cornea bordered by infiltration due to bacterial poisoning suffused into the cornea from the anterior chamber side. In ring-abscess the base of the necrotic wedge is posterior, whereas in the case before us the base of the necrotic wedge is anterior. The changes otherwise are very much alike. Is it not possible that some noxious material has affected this cornea from in front and produced the necrotic wedge, with its apex backward, comparable to the ring-abscess with its apex forward?

DR. JOHN E. WEEKS, New York: I should also like to ask whether the white dots that we see deep in the cornea in disciform keratitis were present in Dr. Verhoeff's case. I have seen many cases of herpes zoster with affections of the cornea, but I have never seen disciform keratitis associated

with herpes zoster. The neuropathic findings peculiar to herpes zoster cannot, it seems to me, obtain in those cases in which, by means of aseptic measures, the condition is corrected or recovery takes place rapidly, as occurs in certain cases of disciform keratitis.

DR. RYUZO KODAMA, Tohoku, Japan: Additional light could be thrown on these and similar pathologic problems by a more exact study of the intra-ocular circulation. A comparatively simple method of observing this is to administer potassium iodid by the mouth, subcutaneously, or in the veins, and follow that by the introduction of minute quantities of iodin into the aqueous humor.

DR. F. H. VERHOEFF, Boston: In regard to Dr. Brown's suggestion as to an analogy between the condition I have described and ring abscess, I would say that there was no such analogy in this case. In ring abscess the trouble is evidently due to toxins coming from behind. As the term indicates, the condition is an abscess, the ring being due to a dense collection of pus-cells. In my case the toxins arose at or near the anterior surface of the cornea, and the intensity of their action progressively diminished posteriorly.

In connection with what Dr. Weeks said, I would state that in speaking of these different conditions of disciform opacity I did not mean to imply that all these cases would come under what Fuchs calls disciform keratitis, but simply to indicate that disciform opacity of the cornea may be produced by a variety of causes. In regard to herpes zoster, Fuchs noted that it sometimes led to keratitis profunda or disciformis, and I have myself seen disciform keratitis follow herpes zoster.

REPORT OF TWO UNUSUAL COMPLICATIONS OF HERPES ZOSTER OPHTHALMICUS: (*a*) ACUTE RETROBULBAR NEURITIS (NEURITIS AXIALIS); (*b*) ACUTE GLAUCOMA.

CLARENCE A. VEASEY, M.D.,
Spokane, Washington.

Ocular complications of herpes zoster ophthalmicus are by no means rare. It is believed by most authorities that they are most frequently observed when the nasal branch is involved. The conditions usually noted are keratitis, anterior uveitis, and at times a more or less extensive iridocyclitis. The notes of the following two cases show some points of unusual interest:

Case I.—*Acute Retrobulbar Neuritis (Neuritis Axialis) Complicating an Attack of Herpes Zoster Ophthalmicus.*—Mrs. J. K. M., aged about forty, married, was first seen by me December 8, 1911, on the third day of an attack of herpes zoster ophthalmicus on the right side for which she was being treated by the family physician. The right eye was somewhat congested and lacrimation was quite free, but there was no ulcer and no visible ophthalmoscopic change. Four days later, or on the seventh day of the attack of herpes, the patient first observed that vision in the right eye was almost entirely abolished, there remaining only a small portion of the upper field. She was an exceedingly intelligent woman, and stated that when the vision first began to disappear she observed a dark area directly in the center of the field which gradually became larger and larger until at the time I saw her, on the date mentioned, there remained only a very small area in the upper portion of the field. No ophthalmoscopic change in the nerve or fundus could be detected. The following day vision was entirely abolished, not even

light perception being present. The pupil was small and still no visible ophthalmoscopic change could be observed. There was no corneal involvement at any time and no involvement of the nasal branch of the nerve existed during the attack of herpes.

An examination of the urine revealed a small amount of albumin. An examination of the blood showed the amount of hemoglobin to be normal and the white corpuscles but slightly increased. Accessory nasal sinuses negative.

On January 2d of the following year, nearly four weeks from the beginning of the herpes, and more than three weeks from the beginning of the neuritis, central vision was still abolished by a large central scotoma, the vision of the peripheral field having improved. A week later the patient could count fingers with this eye at two feet. The optic nerve was now quite pale and distinctly atrophic.

In spite of mercurial inunctions, the iodids, pilocarpin sweats, and subsequent daily strychnin injections into the temple, not only could no further vision be restored, but the small amount present became entirely abolished, the eye remained totally blind, the optic nerve completely atrophied.

A few weeks later the patient developed appendicitis and was successfully operated upon. She had always been rheumatic, and had had several severe attacks for which she had taken hot and mud baths at one of our local resorts. She had also been subject to supra- and infraorbital neuralgia. The attack of herpes zoster ophthalmicus, however, was the first she had ever had, the acute retrobulbar neuritis appearing a few days after the beginning of the attack and passing rapidly to total blindness with complete optic nerve atrophy.

So far as I have been able to ascertain in the search of the literature the case is unique, as I can find no mention of acute retrobulbar neuritis complicating a case of herpes zoster ophthalmicus.

Acute retrobulbar neuritis has been reported as of septic origin and due to focal infections. Lambert and Hansell, at the meeting of the American Ophthalmological Society in 1918, reported such cases, and in the discussion of their papers Shumway, Shoemaker of St. Louis, Weeks, Sutphen, and Carpenter referred to additional cases. The above case

was observed before we were studying focal infections. It has been shown recently by some one, I believe, that herpes zoster may arise from a focal infection. Whether this was true in the above case, and the acute retrobulbar neuritis, as well as the herpes zoster, was due to a focal infection, or whether the neuritis was simply a complication due primarily to the herpes, of course it would be impossible to state.

CASE II.—*Acute Glaucoma Complicating an Attack of Herpes Zoster Ophthalmicus.* On November 5, 1918, A. B., an unmarried male, aged about thirty, presented himself for diagnosis of the condition of his right eye. The following history was obtained: Three weeks before a number of blisters on the right forehead and on the right temple and side of nose had been observed. There was also marked swelling of the eyelids. Since then the vision of the eye had been poor.

The cornea of O.D. was peppered with minute areas of superficial infiltration, as if there might have been broken-down herpetic blisters. The whole cornea was quite hazy; the anterior chamber was apparently of normal depth and the pupil widely dilated and immobile. There was marked pericorneal injection. No fundus examination was possible on account of the haziness and peppered condition of the cornea. The tension by the Schiötz tonometer was 35 mm. V.R.E. 1/45; L.E. 6/5.

The patient was a Christian Scientist, and had been under the care of a Christian Science reader since the beginning of the attack. He stated that he had no pain, but his facial expression and his worn-out appearance showed that he had suffered severe pain, although, I understand, Christian Scientists do not admit that pain exists.

The typical spots of herpes zoster ophthalmicus in the stage of clearing up were observed. The nasal branch was affected as well as the supraorbital. The patient could give no idea as to the length of time the glaucoma had been present.

He was given a solution of pilocarpin for instillation into the eye, together with a purge and hot compresses, and within three days the tension had become normal. But the vision was still reduced as before, probably because of the corneal

condition and the length of time that the tension had been elevated. The patient, during the few days of his appearance at the office, was always under the care of a Christian Science reader, and after these few days' observation disappeared and has not been seen since, so it is not known just what the ultimate outcome was.

This case seems to be one of acute glaucoma complicating the attack of herpes zoster ophthalmicus. Such a condition is comparatively rare. Weeks, at the meeting of the American Ophthalmological Society in 1917, reported the histories of three cases and reviewed the literature.

As to the etiology, it has been shown that the aqueous humor is changed in all cases of inflammation of the uveal tract. In some there has been found an increase in albumin, and in the aqueous of a glaucomatous eye there has been shown to exist both organic and inorganic matter. Weeks states that in a case of glaucoma secondary to a tubercular uveitis he obtained a decidedly positive test for globulin in the aqueous. Because of the above conditions he concludes that the acute glaucoma is due directly to the changes which have occurred in the aqueous humor and the inability of the lymph-spaces at the filtration angle of the anterior chamber to permit of proper filtration because of these changes.

If miotics fail to relieve the tension, operative procedure should be undertaken at once.

DISCUSSION.

DR. ARNOLD KNAPP, New York: The association of glaucoma and herpes is surely a very interesting one, as it may throw some light on the function of the ciliary ganglion. During the past winter I observed a case of herpes that explained the glaucomatous condition as a symptom of cyclitis. A woman of fifty-five years developed high tension after herpes zoster -a tension of between 50 and 60 with the Schiötz tonometer. Under the use of pilocarpin this tension

was reduced and the attack passed off. During the next six weeks the eye was quiet, except that three definite corneal deposits were present. This suggests that the increased tension in herpes is merely a cyclitic manifestation, due probably to the same toxic cause as the herpes. This patient, four to six months later, developed marginal ulcers of the cornea, for which a mydriatic had to be given. I feared to do this, but no return of the glaucoma resulted.

DR. G. E. DE SCHWEINITZ, Philadelphia: Rise of intraocular tension in association with herpes zoster ophthalmicus is not, I think, very uncommon. Recently I examined a patient after the herpes of the forehead had subsided, and an associated keratitis had practically disappeared, but a persistent increased intraocular tension remained, always controlled by mioties, but always reappearing when they were discontinued. Iridectomy was evidently indicated. To decide whether a miotic or mydriatic shall be used is sometimes difficult. In one patient under my charge some years ago, on the third day of a violent herpes zoster ophthalmicus, without corneal lesions, the anterior chamber suddenly deepened, the pupil contracted, a faint ciliary flush appeared, and the tension rose rapidly. In this case mydriatics produced a satisfactory result: the eye was most carefully watched during their use. Such cases are certainly, as Dr. Knapp suggests, due to a cyclitis. A sequel of the case just mentioned was a quadrant atrophy of the disc, due, I think, to vascular changes. Although the field is defective, the central vision is fairly good.

DR. F. H. VERHOEFF, Boston: In connection with the ocular complications of herpes zoster I should like to refer to a case that I had about eight years ago. This patient had a slight keratitis. She also had a mild iridocyclitis and slight opacities in the vitreous. When these cleared up I noted that she had a typical unilateral Argyll-Robertson pupil. She had a negative Wassermann reaction, and no signs of tabes or other syphilitic disease. She has remained in perfect health ever since, but the Argyll-Robertson pupil persists unchanged. The pupil on the other side is absolutely normal in its reactions. This case strongly supports the view that the Argyll-Robertson pupil of tabes is due to a

lesion of the ciliary ganglion. In herpes zoster you sometimes get oculomotor paralysis, so that it is easy to see how the ciliary ganglion could be attacked.

DR. ALLEN GREENWOOD, Boston: It has been my custom to carefully try the tension in all the cases of herpes zoster ophthalmicus, because of past experience. I have one case, which it is well to put on record at this time, of bilateral herpes zoster — the only case that I have seen. In that case there was increased tension in both eyes, and in spite of all treatment, one eye came to enucleation. In the eye on the other side the tension was reduced with miotics, but for several years afterward there were repeated attacks of herpes of the cornea, with increased tension, relieved by miotics. The patient finally, at eighty years of age, lost this eye following an attack of herpes of the cornea that became infected, causing panophthalmitis. This case showed the multiple scars of the skin along the course of both supraorbital nerves, so characteristic of herpes.

DR. C. F. CLARK, Columbus, Ohio: I feel that the points that Dr. de Schweinitz has brought out in this connection are extremely important from the practical point of view. I have now under treatment a man who had a typical case of herpes zoster in which, on investigation, we found a positive Wassermann. He had been under treatment for many weeks for glaucoma. The herpes was recognized, and he undoubtedly had increased tension. He was under the active influence of eserin, prescribed by his local oculist, but his case was going to the bad, as there was active iridocyclitis in connection with the glaucoma. It required only a few moments to discover that this was the case, and, as the iridocyclitis was the most important factor, I deemed it was well to try the effect of a mydriatic in place of the miotic he had been using. The specific condition underlying it, of course, also required treatment. He had immediate relief when put under the influence of an active cycloplegic.

The important question in therapeutics here is how we shall determine, as quickly as possible, when to discontinue miotics in what you might call symptomatic glaucoma. I am coming to the conclusion that a very large number of cases of increased tension are to be traced to the localized

or immediate effect of obstruction of the filtration angle, and are not to be classified as that form of true glaucoma which will resent the use of atropin. In other words, I think that when glaucomatous symptoms arise in the course of other diseases of the eye, these may be treated immediately with impunity by means of a cycloplegic, if we can assure ourselves that we are not dealing with a true case of idiopathic glaucoma.

DR. ROBERT S. LAMB, Washington: I have noted, in connection with increased intraocular tension, not only with herpes, but also with some other conditions of allied character, that there is a suggestion of what appears to me to be a funnel-shaped iris. The appearance of depth in the anterior chamber seems to be associated with a narrowing pupil, and the iris appears to recede toward the pupillary margin. In these cases I have found invariably that I can use a mydriatic without damage and I think that, as DR. KNAPP says, they are probably due to an iridocyclitis.

DR. W. H. PARKER, Detroit: I wish briefly to place on record a case similar in character to those previously reported, glaucoma occurring in a case of herpes of the brow and side of the face, in which there was a decided increase in tension. The tension was not determined by the tonometer, but estimated by the fingers merely, but it must have been about two or three. There was no question of the increase in tension. I persisted in the use of eserin, and was not a little worried about the course that the case was taking. It was only after the tension had been reduced, although not to normal, that I ventured to put in atropin. Within a comparatively short time after this had been done the tension diminished, and it remained normal. After the pupil was dilated I discovered distinct evidences of low-grade iridocyclitis. The relation of the two at the time did not occur to me. I think that it would have been better in this case if the atropin had been used earlier.

DR. HIRAM WOODS, Baltimore: In a late number of the *American Journal of Ophthalmology* some one whose name I do not recall made a distinction between symptomatic hypertension and glaucoma. Dr. Clark has called attention to

that subject, and it seems to be confirmed by the observations narrated. I want to add one more case, that of a lady, thirty-eight years of age, who presented definite herpes zoster ophthalmicus. After a few days there developed pain, circumcorneal flush, with increased tension. The pupil contracted; the eye was tender to pressure. In other words, there were typical symptoms of iridocyclitis. The tension was 35 to 38, just enough to alarm. The queer thing was that as soon as a miotic was used (one-tenth grain of eserin, or one grain of pilocarpin to the ounce) the pain was increased. I then used in succession a 5 per cent. solution of euphthalmin, then homatropin, and finally atropin, taking the tension carefully as the stronger mydriatic was used. The tension gradually came down. It was evidently a case of secondary iridocyclitis with hypertension.

This introduces an important subject: When does mydriasis do good, in spite of apparent hypertension? There are cases of that kind. I should say we ought to look for such a possibility when an anterior uveitis is not doing well, and hypertension appears with a small pupil: but one cannot talk dogmatically on this.

Every now and then, we hear an allusion to chronic appendicitis in connection with uveal changes. Dr. Bruns, at our meeting some years ago, referred to a mydriasis that disappeared after removal of a chronic appendix. Dr. Veasey has suggested a similar association. My patient, in the course of this eye trouble, developed suddenly a flare up of an old chronic appendicitis. Dr. Finney was called in and operated. Within four days, her eye cleared up and has remained normal ever since. Whether this was *post hoc* or *propter hoc*, I do not know.

DR. JOHN E. WEEKS, New York: We all know that any inflammation or irritation of the iris, whether following operation or following disease, produces a change in the character of the aqueous humor; and that in certain cases this change in the aqueous produces elements that will not pass readily through the lymph spaces. In these cases we are apt to get hypertension. We all know, also, that in herpes zoster ophthalmicus, the iris is affected, and in some cases, the ciliary body, whenever the cornea is affected; and

it is possible that the iris and the ciliary body may be affected when the cornea is not affected. A rise in tension in these cases is easily explained on this hypothesis. The use of miotics or of mydriatics in these cases may be resorted to in a tentative way. I have frequently seen that a mydriatic would produce a more beneficial effect than a miotic; but the reverse is also true. In some instances the patient must come to operation because, in addition to the interference on the part of the changed aqueous humor, there is a condition present in the eye that tends to keep up the intraocular tension. There were two cases that came to operation in my clinical service. One was referred to me by Dr. Cutler, who had observed it for some time. Consequently, although many cases may be greatly relieved by miotics or mydriatics, in a certain small percentage operation must be undertaken.

DR. LEE M. FRANCIS, Buffalo: On this question of the use of miotics with cycloplegics in increased tension, it must not be forgotten that in this type of cases the corneal loup will frequently provide one with valuable information. If there is a deposit on Descemet's membrane, even one or two spots, the use of a cycloplegic is clearly indicated.

SOME CASES OF LETHARGIC ENCEPHALITIS.

HIRAM WOODS, M.D.,
Baltimore, Md.

Since the early part of 1918 a peculiar disease, termed lethargic encephalitis, has been appearing sporadically throughout Europe, and more recently in America. Because of the frequency with which paralysis of the eye muscles occurs the disease was at first termed lethargic ophthalmoplegia. The muscular abnormalities are peculiar, the usual causes of paralysis, syphilis, diabetes, and tabes are absent. Without actual paralysis there is often a nystagmoid action of the ocular muscles. There is a tendency to spontaneous recovery.

Insomuch as the ocular manifestations do not seem to have been heretofore made the object of special study, it has seemed worth while to report somewhat minutely several cases which I had the privilege of observing during the months of February, March, April, and May. In the seven cases, the diagnosis of lethargic encephalitis seemed justified, although in one (Case VII) it appeared in the end erroneous.

Historic.

The disease appeared first during the winter of 1916–17 in Vienna, and was termed "Encephalitis Lethargica" by von Economo.[1] In March, 1918, Netter,[2] at the Societe Médicale des Hôpitaux at Paris, drew attention to several cases of lethargic encephalitis which were occurring sporadically throughout Paris. In the April following, in England, seven cases were reported by Harris,[3] and ten by Hall,[4] who at this time were inclined to believe the disease due to an

infection by bacillus botulinus from ingestion of contaminated food. This assumption was, however, immediately questioned by McCaw, Perdrau and Stebbing,[5] and still later by Melland.[6] Meanwhile many additional cases were reported. On May 5th, at the Academy of Medicine of Paris, Netter[7] again reported upon cases which were appearing in increasing numbers. At this time Netter drew attention to the similarity of this outbreak with the epidemic of Nona, which in the spring of 1890 followed the pandemic of influenza. Throughout 1918 cases continued to occur in France and England, causing such concern in England that the epidemic was made the subject of an extended investigation by the Local Government Board, through their Medical Research Committee.

In this country the disease seems to have appeared early in 1919. On February 21st, at the Institute of Medicine of Chicago, during the discussion on influenza Dr. Peter Bassoe[8] reported having seen several cases in Chicago. Lethargic encephalitis was the subject of editorial comment in the *Journal of the American Medical Association* in February, 1919, and again in March, while cases were reported by Ely[9] in April and by Tucker[10] in May.

The symptoms of the disease as described by the above authors consist in a rather insidious onset, the patient becoming languid and drowsy, with or without headache and vomiting. This drowsiness gradually deepens into a profound stupor. This stupor may last for days or weeks. Almost as common as the sleep are the muscular and nervous phenomena. These usually point to an involvement of the bulbopontine area, and consist of ophthalmoplegias of various extent, usually extrinsic (ptosis, recti muscles), more rarely intrinsic. Common paralyses also are those of the facial nerves, of speech, and deglutition. More exceptionally general muscular tremors are observed, and but rarely is there paralysis of the limbs. Melland[6] states the case as

follows: "Special symptoms produced by the disease depend, of course, upon the particular region of the gray matter of the brain involved. For example, polioencephalitis superior, which affects the nuclei of the cerebrum and cerebellum, may give rise to marked mental changes, coma, hemiplegia, diplegia, and ataxia, while polioencephalitis inferior, which affects the nuclei of the pons and medulla, may cause paralysis of one or other or several of the cranial nerves, and combination of the two may be met with."

Fever is usually present, but not always, and is not of long duration. When present it simulates the temperature chart of typhoid fever. Kernig's sign is rarely present. The examination of the cerebrospinal fluid shows only slightly abnormal findings. The tension is usually normal or only slightly raised. Globulin and glucose are usually not present. The cell count is not generally greatly elevated and, when increased, the increase is in lymphocytes. Indeed, Netter considers the relatively normal appearance of the spinal fluid to be of great aid in the diagnosis.

The course of the disease is variable, running from several days to several weeks or even months, and terminates usually in complete cure or in death without further bulbar phenomena. In favorable cases the change for the better usually comes sharply, but psychic and somatic changes may persist for some time, difficulty in accommodation being one of the most persistent symptoms. The mortality appears to be about 50 per cent. (Netter). Others put it at a lower figure.

The pathology of the disease is obscure. The macroscopic findings reported by various authors were slight, and consisted generally in meningeal congestion, petechial hemorrhages throughout the gray and white matter, and in one case edema and congestion in the floor of the fourth ventricle.

Microscopic examination showed brain lesions somewhat

similar to those occurring in the cord in poliomyelitis. These lesions consist of a perivascular cellular infiltration, especially in the bulbopontine region and around the nuclei. In the cases showing the symptoms of polioencephalitis superior the lesions were correspondingly higher up in the cerebrum.

As to etiology, in England it was first thought to be a cerebral toxemia due to bacillus botulinus, but more prolonged observations and bacteriologic examinations[11] showed this to be erroneous. Likewise, pathologic, bacteriologic, and animal experimentation showed the disease to be distinct from anterior poliomyelitis.[12] Netter reports that von Weisner[11] claims to have reproduced the disease in monkeys by the intradural inoculation of brain emulsion from a patient dead of the disease, but was unable to reproduce the disease if the brain emulsion was passed through a porcelain filter, showing it was not due to a filterable virus. Von Weisner further claimed to have isolated a Gram-positive coccus from the brains of subjects and monkeys who have succumbed to the disease. These findings were not, however, substantiated by bacteriologic researches and animal experimentation of the English investigators, their researches giving negative results.

Several observers in this country, notably Bassoe and Tucker, have emphasized the occurrence of the disease following influenza, and regard it as a cerebral manifestation of the disease. The English investigators, however, suggest that lethargic encephalitis is an autonomous infection, and until conclusive proof can be brought forward proving to the contrary the disease must be regarded as a "maladie sui generis," of which the specific causative agent has not yet been discovered.

Case I. (Referred by Dr. Wm. G. Coppage.)—*Synopsis.*—Exposure to influenza and diphtheria. Lethargy ten days; diplopia, anisocoria, cycloplegia, partial ptosis, nystagmoid

movements, optic neuritis. Four months after onset, defective action in inferior recti and accommodation, normal central vision, and field contraction, the last a late development.

M. N., aged thirteen years, came to my office February 18, 1919. He gave this history: Well up to ten days ago. In January was exposed to influenza but did not have it; two children in the family had diphtheria; patient had had no symptoms of disease, and there had been several cultures taken from his throat, all negative. On February 9th he visited Camp Meade, and on returning home had diplopia and eye pains. Drowsy for ten days before I saw him.

I found him sound asleep in the waiting room; he roused easily, walked into the office, and sank instantly into stupor. Temperature 98°, pulse 42. He was mentally clear when awake. Could open eyes widely, but lids drooped and presented appearance of moderate double ptosis. Anisocoria: left pupil larger; doubtful light reaction left eye; very slight, right. No convergence contraction. Extrinsic muscles: lateral movements normal both ways, with slight rotary nystagmus at extreme end, each direction. Made no effort at convergence until the test-object was within 8 or 10 cm. from the eyes. Then he used left lateral motion, fixing with the right, the left eye suddenly diverging. Up motions normal; down, entirely lost, both eyes. Orientation defective in all fields except above. Accommodation lost, but he read at 33 cm. with sph. +3.5, either eye. V.R.E. 20/30, L.E. 20/20−.

Ophthalmoscope showed blurred neuroretinal margins and engorged veins, judged by comparison with size of arteries. Fields were impossible until March 11th, three weeks later, when they were normal. At his first visit I was inclined to the diagnosis of brain tumor on account of the low neuritis, slow pulse, and stupor, but the character of paralysis, absence of nausea, and history of exposure to infection made this diagnosis uncertain.

The boy was seen at his home the next day, February 19th, with Dr. H. M. Thomas. In addition to the above, we noted weakness of both facials, Kernig sign, slight stiffness of neck, and tenderness over masseters; patella reflex exag-

gerated, other deep reflexes normal. The boy could be made to walk, but the gait was unsteady, and he would sink into a chair or on a bed and fall into stupor if left alone.

He was sent to the Union Protestant Infirmary for study. The condition continued as stated for three days, when the lethargy lightened. He was in the hospital to March 5, twelve days. During that time he presented a variation of symptoms. At times the pupils responded to light almost normally. Then, after a few hours, they would dilate ad maximum and become immobile. No accommodation. The pupils stayed unequal, the left always larger than the right. Twice the left pupil changed its shape from regular, full dilatation to an oval, with long diameter horizontal. There was similar variation in the deep reflexes. One day all were lost except the left knee. Then they returned. Abdominal reflexes were absent for several days. Dermatographia was constantly present. He voided urine involuntarily. At times the body muscles twitched spasmodically. Kernig's sign persisted. It was always more painful on the left side. The weakness of the facials, noticed on February 19th, developed into an almost complete double paralysis and then cleared. Temperature varied from 99° to 101° for three days, then became normal.

Laboratory findings were: urine normal; blood and spinal fluid Wassermann negative to all tests, the fluid coming under normal pressure, drop by drop, and clear. Cell count, 39 to c.mm., slightly positive globulin, no organisms. Leukocytosis 7000. After a week in the hospital with these varying symptoms the lethargy passed off and the boy lay in bed awake, rational. He left the hospital with all symptoms improved except the low grade of optic neuritis; paralysis of accommodation, and inferior recti and slight left facial; also unequal pupils, with a slight light and no convergence response.

March 11th, six days later, I found the following: V.R.E. 20/50; L. E. 20/40. The papillitis had about disappeared. Left pupil the larger. Good light, but slight convergence reaction, none to accommodation. Changing position of the eyes from above to the horizontal plane or lateral movements produced rotatory nystagmus. Eleven days later he showed a little motion down—15° to 20° on perimeter. V.R.E.

20 40; L.E. 20 30. Pupillary reaction was good for light and convergence, which had completely recovered. Accommodation had improved about 1 diopter. From this time there was improvement with, however, occasional variations. These affected vision and mobility. Vision varied from 20 30 each on March 22d to 20 50 on March 27th. On the latter day all the gain in accommodation had been lost. On April 17th, two months after onset, vision reached 20 15. There was no accommodation; a sph. +3.5 was needed for reading at 33 cm. This held ten days later. The left pupil remained the larger, but each showed normal reaction. His down movement had increased on April 26th. At the termination of both up and down movements there was a tremor of the eyes before they became quiet. This was not the case with lateral movements. Accommodation was still nil. V. 20/15 each.

May 26th, five and a half weeks later, his condition was: V.R.E. 20 15. Read newspaper print for a moment at 40 cm. with the right eye, but could not hold it. Accommodation about 2 diopters. V.L.E. 20 15. Accommodation 1 diopter. All movements normal except downward. Slight nystagmoid movements at end of excursions up, down, or lateral. Fields show contraction, in comparison with those of six weeks ago. General demeanor heavy, and he tires quickly on keeping eyes fixed. Fields were unreliable.

Case II.—*Synopsis.*—Previous influenza, lethargy, followed by "jerking of eyes and difficulty in locating objects till the eyes get still." (Patient's description.) Nystagmoid movements and facial paralysis.

Mr. N. W., aged twenty-nine years, farmer, saw me first on March 4, 1919. He had a myopia of 1.25 diopters, with normal vision. History of influenza the first week in January; recovered. On February 20th, at the automobile show, he fell asleep. His wife woke him, he walked around a few minutes, and went to sleep again. He returned home and slept three days and nights. Felt well, but could not keep awake. On February 24th, was giddy and is still occasionally so. First eye symptoms on February 25th. He said: "Lids and eyes twitched if I looked at anything;

the end of last week my eyes did not keep still long enough to pick out print."

Examination showed normal fundus and media; with glasses, V.R.E. 20/40; L.E. 20/20. The right obtained 20/20 when "it got quiet." Punctum proximum accommodation, 5 diopters each. Pupillary reflexes and convergence normal. Fixation at any point, distant or near, was followed by a rotatory and sometimes vertical nystagmus which lasted about three seconds. Then the eyes became quiet. As soon as the position of the eyes was changed and a new point of fixation sought, the oscillations were renewed. When the eyes were closed, there was a tremor of both upper lids and an occasional orbicularis twitching. This was also noted in lateral movements either to the right or left. This condition was observed for three days.

Two days later, March 9th, he developed a curious muscular action. Convergence and lateral movements were normal, save for the oscillations, which passed off in a few seconds. The same was true when he looked downward; but on looking up, following a finger or test object, the eyes moved slowly up a certain distance and then, as though working on a spring, converged violently. This spasmodic convergence was accompanied by further jerkings inward. He was totally unable to abduct the eyes when they were directed above the horizontal plane, but when he was told to look down, the axes became parallel.

On March 11th he developed right facial paralysis. He said the drawing of the face to the right was a "queer trick" he had. On March 12th I asked Dr. Thomas to see him with me. All reflexes were normal. Sometimes the hands trembled, also the neck muscles. On getting up from a chair the thigh muscles went into a quick irregular tremor, lasting a few seconds. After that he walked normally. It was impossible to get the patient to the hospital for laboratory study. After nearly three months his condition is as follows: May 10th, oscillations of eyes slight, but definite. On May 23d my case notes read: "1. In up motions left eye lags a little behind the right, but on urging, the left eye is pulled up as far as right. 2. In fixation on horizontal plane a tiny rim of left sclera above the cornea is visible; none in the right eye. 3. In motions up, slight rotatory nystagmus,

sometimes two or three jerks, then eyes are kept still. Face is a little drawn to the left, which is the opposite of condition observed March 11th. Pupils, accommodation, convergence, fundus, and media normal." He can read and says he knows he is better because his horse "does not seem to fly about when he is getting into the saddle."

CASE III.—*Synopsis.* Exposure to influenza. Had "cold" and headache. Lethargy and occasional nystagmoid movements.

E. S., boy, aged fourteen years, consulted me February 18th for headache and drowsiness. The pain had come first about two weeks previous; slept all the time. He had been exposed to influenza, but did not think he had had more than a "heavy cold" in December, 1918. Still weak.

I found drooping of both upper lids. V. 20/20 and accommodation 7 diopters each eye. Manifest refraction error. R.E. sph.+1.00⊂cyl.−.37 ax. 180°; L.E. sph.+1.50⊂cyl.−.37 ax. 180°. Fundus and media normal. The only defect found in motions was in lateral fixation. For instance, in indirect ophthalmoscopic examination the eyes would suddenly roll up and the upper lids droop. The boy said the eyes did not hurt, and he did not know why he could not keep them open. He was so drowsy I could hardly keep him awake long enough to examine the eyes. Lateral fixation either way produced nystagmoid movements.

Under date of March 7th his physician, Dr. W. H. Marsh, of Solomons, Md., wrote: "There has been a great improvement in E. S. since his return home. He is now at work, the drowsiness has about disappeared, and there is more snap about his movements." There was no opportunity to study this case thoroughly, yet the drowsiness, drooping of the lids, involuntary motions, and slow recovery were characteristic of the other cases more fully reported.

CASE IV.—*Synopsis.*—Ocular symptoms the first to appear. Sudden diplopia and left internal squint. Saw a physician who used atropin. Followed by two weeks of lethargy with very slow return of pupillary reaction. Accommodation still defective after nearly three months.

Miss X., aged nineteen years, telephone operator, was sent me by Dr. C. H. Kriete, of Aberdeen, on March 14, 1919.

She had had no recent illness. There was a left internal squint of 45°. When the left eye was excluded, the strabismus shifted to right and the excluded eye trembled. She stated that two days before, while at work as a night operator, she suddenly saw double. A local physician, not her regular attendant, had used atropin. This was the day before she came to me. Her refraction under atropin was, V.R.E. 20/200, 20/20 by sph.+2.00; V.L.E. 20/200, 20/20 by sph.+1.5. The atropin had had no effect on the squint. There was a definite defect in left lateral motion; the left eye would not abduct to the canthus, while the right eye would. Slight left ptosis. In view of the suddenness of the symptoms and the defective action of the left external rectus I decided to refrain from treatment until the effects of the atropin had worn off, advising absolute rest in the meantime.

I saw her again in a week—March 21st. It was then that I first suspected lethargic encephalitis. The girl had been asleep the entire week. She would arouse and take her meals and immediately fall into a stupor. The pupils were still widely dilated, and showed a barely noticeable, if any, response to light; none to convergence. She still accepted her atropin correction and the squint had disappeared. She apparently had regained about two diopters of accommodation. There was definite drooping of the left upper lid; all eye motions were good. She was lethargic during examination. She went home and slept continuously for four days. I saw her on March 25th, ten days after the use of atropin, the right pupil larger than the left. Both responded to daylight and convergence. Her manifest error was a 0.5 diopter less than the total correction in the right and 0.25 in the left. She now needed sph.+2.00 added to her manifest error to read at 33 cm. Correction of her manifest error was ordered for constant use.

On April 4th, just three weeks and one day after the use of atropin, the pupils were still dilated and of equal size, but reacted promptly to light. She had normal distant vision and needed 1 diopter added for reading at 33 cm. in the right eye, which was a gain of 1 diopter of accommodation. The left eye had barely a near point of 33 cm., which represents for her age, according to Duane's table, a loss of accommodation of 6 to 8 diopters. With the red glass before one eye

she developed, at 20 feet, a vertical homonymous diplopia, correctable by $2^1/_2^{\circ}$ prism base down before the right eye.

On April 15th, she tried to resume her work. Headache and blurred vision compelled her to stop in a half-hour.

On April 21st, five and one-half weeks after the use of atropin, she was still about 6 diopters short of the accommodation normal for her age. The left pupil was larger than the right. Both reacted normally. The red glass gave homonymous, but not vertical, diplopia.

On May 12th, nine weeks and two days after the use of atropin, there was still inequality of the pupils but good reaction. She now had about 2.5 to 3 diopters of accommodation in each eye through the glasses correcting her manifest error. On May 25th, she had a near point of 25 cm. in the right and 20 cm. in the left eye, equal to 4 and 5 diopters of accommodation, still not over one-half of the accommodation normal for her age. There was no diplopia and she was working more comfortably. She has orthophoria for distance. In view of the transient squint, left ptosis, lethargy, and the slow return of accommodation, I felt that the diagnosis of lethargic encephalitis was justifiable.

Case V.—*Synopsis.*—A "cold" in January, followed by fever, lassitude, and stupor for nearly a month. At the end of that time, left followed by right facial paralysis, paralysis of accommodation of left eye; final recovery.

A. A., boy, aged nineteen years, was referred to me on April 10th by Dr. Wm. H. Pearce. So far as personal observations are concerned there is very little for me to report. The interesting feature of the case is the early history, which has been kindly furnished me by Dr. Thomas, to whom Dr. Pearce sent the patient. This will be given after my own findings. He had normal central vision, no limitation of fields, a near point of 15 cm. for the right and 38 cm. for the left eye. When he looked down he developed lateral nystagmus; continuing to hold this position, the eyes became still. On looking up there were no nystagmoid movements. They developed at once, however, on lateral motion. Pupils were of equal size and reacted normally to light and accommodation. He could shut his eyes tightly and there was no involvement of the lids.

Six days later the boy reported that he had been very drowsy since his last visit. There was a distinct tremor of the upper lids when he closed his eyes, and the same nystagmoid movements on looking up, upon lateral motion or convergence. The most marked change, however, was in the accommodation. The punctum proximum of the left eye had come in from 38 to 20 cm.

The early history furnished me by Dr. Thomas shows that the boy was a student at boarding school in Virginia, and in January, after climatic exposure, had what was supposed to be a cold. This was accompanied by dizziness and diplopia. He seems to have been more or less miserable for the next three or four weeks at school, suffering from giddiness, drowsiness, etc. Early in February, a month after the onset, he developed a left facial paralysis. He returned to Baltimore and shortly afterward the right facial was involved. Dr. Thomas saw him on February 4th. He noted the expressionless face, wide-open eyes, widely dilated pupils, with very slight reaction to both light and accommodation; pain and nystagmoid movements on lateral motions, masseters painful on pressure, and almost complete double facial paralysis. At a later visit Dr. Thomas noticed paralysis of accommodation of the left eye and nystagmus on any lateral motion. There was gradual improvement in all these symptoms, but all through February and March the boy had periods of stupor and was unable to use his eyes. At times he read better than others—simply could not see the print. At the end of March he came to Dr. Pearce with a complaint of pain in the region of the heart apex. Dr. Pearce found a pleuropericardial friction rub, which disappeared when the boy turned on his right side. Pain, temperature 101° F.; rapid pulse which persisted for forty-eight hours and disappeared as mysteriously as they had come. Anorexia and prostration followed for a fortnight. I saw this boy again on May 29th. He thinks he is well, and he is, with the exception of lateral nystagmoid movements when he looks upward and tries to hold the eyes in this position.

I have hesitated to include the following cases:

CASE VI.—*Synopsis.*—Eye symptoms first to appear. Patient aged sixty-five years. On this account possibility of

undiscovered degenerative changes. Left abducens paralysis and dilated and feebly acting pupils the only eye symptoms; most of the others pointing to involvement of spinal ganglia.

Mrs. M. E., aged sixty-five years, was seen in consultation with Dr. J. A. Zepp on March 22d. She had been under observation for three weeks. Some weeks prior to seeing Dr. Zepp, she had been greatly frightened, and since then had been nervous and sleepless. Dr. Zepp found her with double vision and vertigo. The symptoms were unchanged for a week, when Dr. T. B. Futcher was called in consultation. Dr. Futcher was inclined to a diagnosis of cerebral arteriosclerosis, but nothing was positive except that the diplopia was due to a weakness of the left externus.

On March 22d the woman was in a deep stupor. This had come on three days previously. She could be aroused, and a fair examination of the eyes was possible. There was partial paralysis of the left externus, with jerkings and rotation at the excursion end. It was very difficult to keep her awake. Pupils were dilated and responded to light. Ophthalmoscopic appearances were negative. Other symptoms were loss of right patellar reflex and positive Kernig. Pulse 112, temperature 98° F., blood pressure, 165 95. I felt that a positive diagnosis was impossible, but it looked like lethargic encephalitis. This diagnosis was definitely made by Dr. Futcher six days later.

At that time Dr. Zepp phoned that the woman was in profound stupor and had developed right facial paralysis. There was tenderness over the masseters. The right patellar reflex had returned and the left disappeared. Kernig sign persisted. I saw her again on March 31st. There was complete right facial paralysis; both pupils were dilated but reacted slightly to light. She could move her left hand and leg very little, right normally. She had developed tenderness on pressure along the course of the left femoral vein. Temperature 101° F., pulse 110; profound stupor. A few days later she lost control of bladder and bowels. At present, more than two months after the onset of symptoms, this still persists. The lethargy is beginning to lessen, but is still present. Reflexes have returned, and all symptoms are clearing except the bladder and intestinal.

The diagnosis of lethargic encephalitis seems justified by the suddenness of left abducens, followed by the facial paralysis, both of which recovered; stupor and then the symptoms referable to involvement of the spinal cord and, finally, by spinal fluid tests.

CASE VII. Diagnosis doubtful. Right facial neuralgia, right ptosis, total paralysis of right internus, partial of right inferior rectus. Paralysis left externus. No lethargy. Death from respiratory paralysis. Possible metastasis from previously unsuspected sarcoma of unknown situation.

Mr. A. S., merchant, aged twenty-seven years, was sent me on April 14th by Dr. Harry Goldburg. For several days Mr. S. had been suffering from severe right facial neuralgia. Dr. Goldburg wanted the eyes excluded as a cause.

Pupillary reaction, media, and fundus were normal. V. 20/20 each; 20/15 by sph. + 0.75, which corrected his manifest hypermetropia. Punctum proximum accommodation, 22 cm. each; muscular balance, left hyp. — Ex. $3\frac{1}{2}-1^{\circ}$ at 20 feet, and only Ex. 2° at the near point. His manifest correction was ordered, and Dr. Goldburg informed that I thought the eyes were at most merely a contributory cause, if that.

One week later Dr. Futcher told me that on April 18th he had seen Mr. S. in consultation. He had found a complete right ptosis and weakness of the right internal rectus. He suspected lethargic encephalitis. I saw Mr. S. that afternoon with Dr. Goldburg, and found the following: he could not sleep, and was restless and anxious, though rational and free from pain. There were complete right ptosis and paralysis of the right internal rectus. The right eye lagged behind the left in down motion. The pupils were small, but responded to light and accommodation. Accommodation was unaffected. In left lateral motion the left external rectus abducted the eye about half way, when the movement terminated with a few jerks and the eye rotated down and a little out. There was a right external squint of about 20°. Dr. Goldburg was sure that the motions of the left eye were normal that morning. The man had also developed that day vomiting and trouble in swallowing. Pulse was 80, temperature, 98° F. In a word, he had de-

veloped during the week since he was at my office with right facial neuralgia, paralysis of the right levator and right internal rectus, partial paralysis of the right inferior rectus, without involvement of the pupils or accommodation. Between 8 A. M. and 4 P. M. of the day I saw him at his home there had appeared partial paralysis of the left externus, vomiting, and dysphagia. That was all we found, and we all thought it a case of lethargic encephalitis. We were puzzled because of the absence of lethargy.

Three days later Dr. Goldburg phoned me that there were periodic attacks of dyspnea. Blood and spinal fluid Wassermann tests were negative. The spinal fluid came out drop by drop without evidence of pressure; the cell count was 6, with slight positive globulin reaction. On May 4th Dr. Louis Hamburger, who was then associated with Dr. Goldburg, phoned me that the man had been taken to the Union Protestant Infirmary, that he was growing worse, and early that morning had developed defective vision in the left eye. He also told me that a day or two before there had been found a few palpable, small nodules in the skin of the occiput and abdomen. He had excised one from the scalp for examination. He had discovered them through the patient's complaint of pain in back of head when there was any pressure on the occiput. I saw Mr. S. about 1 P. M. He was rational, more or less in a stupor, with respiration of 40, pulse 140. Examination of the eyes was difficult and not pushed; however, I found that the muscular lesions described above persisted. When the right upper lid was raised he saw distinctly and read, while with the left eye print was blurred. There was no apparent explanation. The man died that night of respiratory paralysis. Autopsy was not allowed.

The final point of interest in the case is the result of the study of the excised nodule. Dr. William G. MacCallum, pathologist at the Johns Hopkins Hospital, found it a leukosarcoma. Location of the main growth was impossible, but if the symptoms were due to metastasis, they followed very accurately the course of lethargic encephalitis. The case is retained in this paper to demonstrate the uncertainty of diagnosis. The man had all the classic symptoms of lethargic encephalitis except the lethargy, and numerous cases without this, but with other symptoms, have been re-

corded. He had been examined by two most careful diagnosticians, and if the skin nodules were present at their examinations, they were simply missed. I believe they were of later development—certainly the abdominal.

COMMENT.

Of the seven cases here reported, two gave histories of antecedent influenza—one, a doubtful history, and four, no history of this disease. In view of the negative character of bacteriologic and animal experimentation, and of the undoubted frequency of influenza previous to the onset of the lethargic encephalitis, the most reasonable view appears to be that influenza may reduce the resistance of the individual in such a way as to make a subsequent infection of lethargic encephalitis more probable.

In only one of the cases herein reported was there optic neuritis, and this was of low grade. This finding is in accord with those of previous observers, and also with the general lack of inflammatory and pressure symptoms which characterize the disease, and absence of peripheral nerve involvement. In three of these cases (1, 4, 5) there was serious impairment of accommodation. The pupils were dilated, sluggish, and at times inactive. In another case (6) the age prevented accommodation tests, but the pupils presented similar conditions. All four presented other defects: In case 1 there was involvement of other branches of the third; in cases 4 and 6, abducens paralysis, and in cases 1, 2, and 5, facial paralysis. While paralysis of both the extrinsic and intrinsic muscles has a tendency toward spontaneous recovery, these cases confirm the observation that the return to normal of the intrinsic is slower than that of the extrinsic muscles.

Of especial interest were the nystagmoid movements, which occurred in five of these seven cases. Indeed, in two cases they were the only signs pointing to involvement of the eye

muscles. This nystagmus bore no definite relation to axis of voluntary movement of the eyes. For example, upon lateral movements of the eyes a vertical or rotatory nystagmus appeared.

How are we to explain these various muscular phenomena? The ocular symptoms are clearly of central origin. I incline to the explanation of Melland that clinical phenomena vary according to whether the disease manifested itself as an encephalitis inferior or an encephalitis superior. In cases showing ocular muscular symptoms the disease is doubtless a polioencephalitis inferior, with lesions of the brain stem varying from the level of the anterior tubercles of the corpora quadrigemina, along the floor of the fourth ventricle, to the level of the nucleus of the sixth nerve. These lesions are probably sometimes irritative, sometimes inhibitory, but never destructive. Paralysis of the intrinsic or extrinsic muscles governed by the third nerve is present according to the ganglion cells involved. The nystagmoid movements would thus be due to lesions involving the transverse fibers connecting the nuclei of one side with those of the other, or to lesions involving the posterior longitudinal bundle, which connects the nuclei of the third, fourth, and sixth nerves, or finally to lesions of the association fibers. The character of the nystagmus would vary according to the site of the lesion. It will be recalled that the pathology of lethargic encephalitis is merely a perivascular infiltration, the site of which may vary, and the clinical symptoms will likewise vary with the site of the lesion. Paralysis of the facial, of muscles of deglutition and respiration are examples.

As to the cause of the lethargy, English observers have argued as follows, and to my mind this explanation appears very plausible: The slight fever, slight inflammatory changes in the spinal fluid, and absence of other infectious symptoms made a toxic cause for the lethargy very improbable. The absence of optic neuritis and other pressure symptoms, to-

gether with the generally normal tension of the cerebrospinal fluid, practically rule out increased intracerebral pressure. On the other hand, the low grade of inflammation about the brain stem might well cut off afferent impulses to the cerebrum to such a degree as to cause stupor. In conclusion, we must remember, however, that the actual cause of the disease is unknown, and the pathology still obscure. The explanations herein advanced are those which, in the present state of our knowledge, appear to me most probable, but they are nevertheless largely hypothetic.

I desire to thank Drs. G. H. Grove and G. E. W. Hardy, of the Union Protestant Infirmary Staff, for their coöperation in observing the cases sent to the hospital.

SUMMARY.

A peculiar disease, termed lethargic encephalitis, has been appearing sporadically throughout Europe during the last two years, and has been observed in this country during the last six months. The disease is characterized by an insidious onset, lack of symptoms of an infectious nature, stupor, and involvement, sometimes paralysis, of various muscles, but chiefly the muscles of the eye or face. The ocular symptoms consist of either relative or total paralysis of the intrinsic or extrinsic muscles, ptosis, and nystagmoid movements. One or several of these symptoms may be present. The ocular symptoms have a definite tendency toward spontaneous recovery.

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DISCUSSION.

DR. ARTHUR J. BEDELL, Albany, N. Y.: During the past six months it has been my privilege to see 48 cases of lethargic encephalitis. The variation in the severity of symptoms is one of the most marked features of the disease, and doubtless many of the mild cases have either passed unrecognized by physicians or even without medical advice. Three more or less distinct types have been clinically noted in my cases. The mildest were characterized by sudden diplopia often so transitory and slight that before all serological tests were completed marked improvement or recovery had been reported. On examination these showed a rapid nystagmus, usually lateral, but the vertical not uncommon. There was a tendency to convergence, with sixth nerve paralysis, headache and the usual sense of insecurity.

The next severer type had diplopia practically for all distances, the general discomfort, such as headache and mental depression, greater, the nystagmus more marked and usually accompanied by other nerve paresis, such as the third, fourth, eighth, ninth, tenth, and eleventh nerves. The duration was longer, and in some the mental side was so great that the patients were unfit for work, and two of them were confined to institutions of detention.

The severest type is illustrated by a case, first seen by me, in a sleeping state, having given a history of progressive somnolence with diplopia. The sleepiness progressed, and despite all treatment the patient died. Autopsy proved the findings considered in this disease.

The clinical condition of lethargic encephalitis is more com-

monly recognized by the ophthalmologist, and it is proper that Dr. Woods' paper be given prominence.

DR. G. E. DE SCHWEINITZ, Philadelphia: I have had the opportunity of seeing a number of ocular complications in connection with so-called lethargic encephalitis. In all the lethargic or somnolent stage was marked, and in all the first ophthalmic symptom noted was diplopia. In most of the milder cases the external rectus was the first and usually the only muscle affected; in one the superior oblique. Complete oculomotor palsy of one eye I have also observed. It would seem the ciliary muscle is the last one of the nerve supply to recover perfectly. As is well known, in some instances of lethargic encephalitis double complete ophthalmoplegia has developed a very severe type of this disease of most serious prognostic import.

DR. EDWARD A. SHUMWAY, Philadelphia: During the past winter I have had the opportunity of examining six cases of lethargic encephalitis. In four of them the sixth nerve was alone involved; in one, both the sixth and third nerves were implicated, and later the lower centers were affected, and death ensued from respiratory failure. In the remaining case, the sixth was first affected, then the oculomotor, seventh (right facial paralysis), eighth, ninth, and later the lower centers were successively attacked; on two occasions the patient had sudden failure of respiration, but ultimately recovered.

In four patients there was marked lethargy; in the one fatal case the stupor was profound, and it was difficult to arouse him; one had a curious talkative delirium, which has been previously noted elsewhere. Sitting in the waiting room, and later in the hospital room, he would mutter quietly to himself, would respond to questions when addressed, and then lapse into the muttering delirium if left alone. He eventually cleared up mentally, but when last seen he had still a lack of confidence in his ability to resume his occupation as an engineer. In one the mental confusion was complicated by great nervousness, and fear that the disturbance of mental power would remain permanent and prevent his going on with his career as a professional musician.

In two patients the optic nerve heads were moderately

blurred, and in one a reduction of vision to 6/9 was noted, which was independent of any refractive error. In the fatal case we were unfortunately unable to get permission for an autopsy.

In four there was a definite history of a preceding attack of influenza: the fatal case is included among these; one was complicated by a positive Wassermann reaction of the spinal fluid, but the symptoms developed acutely, as in the other patients, and the recovery of the cranial nerve palsies and the mental confusion was complete, so that Dr. Spiller, who saw him in consultation with me, thought it should be considered a case of lethargic encephalitis.

At a meeting of the Philadelphia Neurological Society in May, Dr. Spiller reported two of the cases I have mentioned, and an additional one, which I did not see. Two fatal cases were reported by others, in which autopsy disclosed the round cell infiltration and areas of hemorrhage in the regions of the centers below the aqueduct of Sylvius, extending downward in the gray matter of the pons and medulla, which have been described elsewhere. Dr. Spiller, at the time, expressed the opinion that, while further pathological evidence and experimental work would be necessary before the etiology could be considered as settled, he felt that the condition might be found to be due to the action of the influenza toxin upon the centers in this part of the central nervous system, instead of upon the respiratory or intestinal tracts.

Dr. T. B. Holloway, Philadelphia: I think that Dr. Shumway, in referring to what Dr. Spiller had said, has hit upon one of the affections from which it is difficult to differentiate the milder forms of this condition. It would be almost impossible wholly to eliminate influenza as a possible source of confusion unless we include it as a factor in the production of this condition. It is by no means an easy matter to differentiate mild specific cases. The diplopia fields are also difficult to work out, especially if the patient has a partial ptosis which may increase during examination.

Dr. Hiram Woods, Baltimore: There are one or two points I wish to speak of. What Dr. Holloway says is undoubtedly true. If I had had time, I should have related my last case, which was in a managed twenty-seven years who had been in

good health all his life, and who developed a right facial neuralgia. This was followed, in a week, by right ptosis; then by paralysis of the right oculomotor nerve; then by a paralysis of the left external rectus. Vision was normal. The intrinsic muscles were spared. He was sent to the hospital, and all possible examinations made. The results were typical of the general findings in encephalitis. He died of respiratory paralysis. A few days before his death we discovered some little nodules, barely palpable, on the scalp. One was excised, and after examination it was found to be a leukosarcoma. The question is, did he have encephalitis or was there a sudden metastasis of an absolutely undiscoverable malignant growth? He had no symptoms of the latter and an autopsy was not allowed.

One thing was interesting about the diagnosis in another case: A telephone operator, nineteen years old, suddenly saw double. She went to see a retired oculist, and he found a decided left internal squint. He put atropin in both eyes, and when I saw her a day later, there was complete cycloplegia. She had an internal squint, a partial paralysis of the external rectus, and a complete atropin cycloplegia. That occurred the second of March. She still has only a maximum accommodation of 2 to $2\frac{1}{2}$ diopters. The way the diagnosis was made was that she went home from my office and slept continuously for ten days. Then they woke her up and brought her to see me, and I found that the accommodation was still paralyzed. She went home and slept for four or five days. Nearly three months afterward she still has only a very low range of accommodation.

COLOBOMA AND SO-CALLED CONGENITAL DISLOCATION OF THE LENS.

C. F. CLARK, M.D.,
Columbus, Ohio.

In 1894 I presented to this Society the history of a case of binocular coloboma of the crystalline lens with accommodative power retained, and a brief review of such cases as I could find in the literature available at that time in the library of the Surgeon General's office, and it has occurred to me that, as these cases are somewhat rare, it might be worth while to place on record the subsequent history of this patient's eyes, with an interesting group of other cases which I have had opportunity to study during the past twenty-five years.

Coloboma and luxation of the lens of congenital origin, while perhaps generally regarded as clinical curiosities, have presented, in the group of cases I have had under observation, some features which have seemed to me worthy of careful study, and, while the advanced students of embryology may have worked out some satisfactory theory which will account for the phenomena observed, certainly our textbooks and encyclopedias of ophthalmology, in their somewhat stereotyped presentation of the subject, have not offered an explanation which will entirely satisfy a critical observer.

It may be that some exhaustive and scientific laboratory work has been done which will supply a really satisfactory explanation of these anomalies, but if so, I have not had the good fortune to see the reports of the investigations on which such explanations are based, and certainly such writers as

have based their theories on the occasional instances of association of coloboma of the lens with coloboma of the iris and choroid, and who speak with apparent confidence of the imperfect or delayed closure of the fetal ocular cleft as the cause, will have to revise their theories to account for the large number of cases which show no evidence whatever of coloboma of either the iris or the choroid. The ingenious theories of some eminent writers of many years ago have been quoted in the text-books from year to year as authoritative without being subjected to critical analysis, but I fail to see how some of the cases I have observed can be satisfactorily accounted for or made to fall in with these theories.

Many of us lack the deep and intimate knowledge of the embryology of the eye necessary to enable us to supply an adequate theory which will account for a coloboma occurring in the upper or lateral border of the lens, or for the existence of a pronounced coloboma of the lens with no defect in either the iris or choroid, but it does not require a deep knowledge of embryology to enable us to detect the inadequacy of the text-book theory which groups these cases together and is satisfied with a glib reference to an imperfect closure of the fetal ocular cleft as an explanation of such phenomena.

It is not always agreeable for learned writers to acknowledge that they do not know, but when one finds a manifestly inadequate theory quoted by one standard authority after another, he is tempted to say that an explanation which does not explain is often worse than no explanation at all.

The case described by me in 1894 was very similar, so far as the defect in the lens is concerned, to one described by Cissel in 1890. My patient, Edward S., of Marysville, Ohio, aged ten years, had marked asthenopic symptoms and a trembling iris, with a marked coloboma at the lower border of each lens. I had his case under occasional observation from 1888 to the time of his death in 1912, and while there was some slight evidence of premature presbyopia at the

time of his death at the age of thirty-four, his lenses had remained quite clear and his corrected vision had improved from 4/18 to 5/7.5— in each eye.

He attended school and reported to me from time to time on account of the occasional recurrence of asthenopic symptoms. These were relieved by a careful correction, making allowance for the changes in his refraction which seemed to vary from year to year and to be due in the main to a gradual change in his lenticular astigmatism.*

In my report of this case of coloboma in Edward S., made in 1894, I made a rather full record of the refraction, both corneal and lenticular, and in my studies of the case after the lapse of many years it was interesting to note that while the myopia remained about the same, namely R. sph. −7.5, L. sph. −5.5, the astigmatism increased from R. cyl. −1.00 axis 10°; L. cyl. −2.75 axis 170° in 1894 (at which date the corneal and total astigmatism were practically the same) to R. cyl. −3.5 axis 180° and L. cyl. −5.5 axis 180° in 1912—an increase of the total astigmatism in the right of 2.5 D. and in the left of 2.75 D., manifestly due to a change in the form of the lens. While in the case of congenital dislocation in Kenneth A. referred to below there was, apparently owing to release from the tension of the suspensory ligament, a considerable degree of myopia and a modification of the astigmatism apparently due to tilting of the lens.

Both of these cases were in boys who were under observation for many years, whose lenses remained clear, and who had good vision when their varying refraction was properly corrected. In one there was a marked coloboma in the lower segment of the lens in each eye, while in the other the lenses

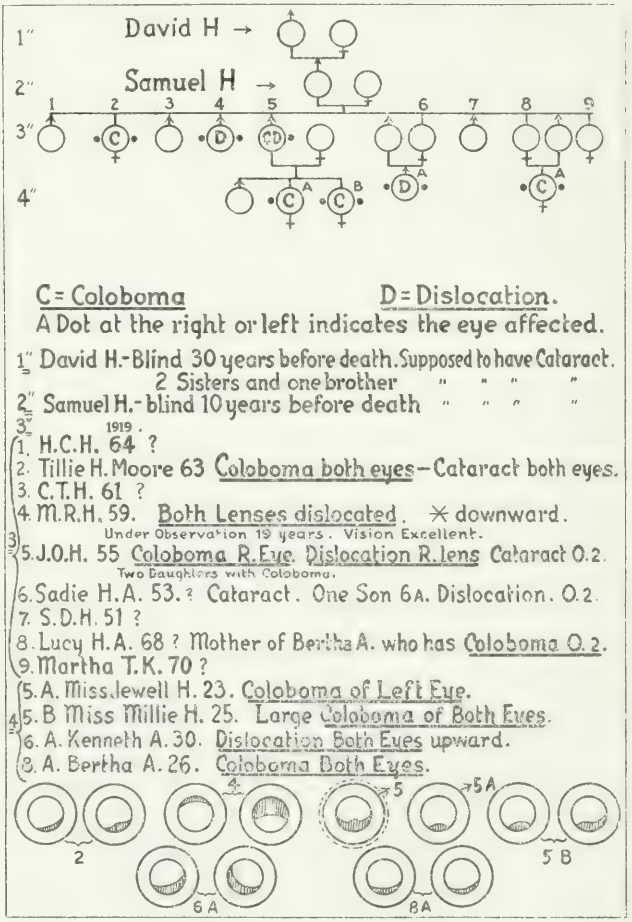
* I wish to call special attention to this point, as I have observed it in a number of the cases of coloboma which I shall report, and to contrast it with astigmatism occurring in a case of congenital dislocation in Kenneth A., in which latter case it seemed to be due, at least in part, to the inclination or tilting of the lens, which, released from the pressure of the suspensory ligament, also caused a marked degree of myopia, remaining about the same for many years.

were dislocated upward and slightly outward. The changes actually observed in the refraction of these cases were apparently quite consistent with what we should naturally anticipate if we observe with care the phenomena of coloboma and congenital dislocation, and the point of great interest to me was that in spite of their deformities the lenses remained clear under the observation which was maintained for a series of years.

In the case of coloboma the lens remained in the normal position, but slowly changed its form, while in the case of dislocation it changed its position as well as its form, and in the latter case I would call attention to the fact that in congenital subluxation, so long as the anterior surface of the vitreous body maintains its normal curvature, the movement of the lens is apt to be such that its posterior surface slides on the wall of the lenticular fossa, and the lens consequently tilts forward at such an angle as to produce a degree of regular astigmatism. While there are great variations in the size of the colobomata and the degree of dislocation in the cases I have had the opportunity to study, the two cases referred to above may be taken as in a degree typical, and I will refer only briefly to a few of the others which present some interesting points.

Out of a total of eleven cases of this class occurring in my practice during a period of thirty-five years, eight had coloboma and four had congenital dislocation; in one case both coloboma and dislocation were found in the same patient, and, while the text-books and encyclopedias almost invariably speak of coloboma of the lens as associated with and dependent upon the same causes as coloboma of the iris and choroid, in not one of *my eleven cases*, and a considerable number of instances in which coloboma of the iris and choroid was observed, could I find the two conditions associated. I am again calling attention to this point, as I wish to emphasize the fact that an ingenious theory concerning a somewhat

obscure histologic subject, if proclaimed by some high authority, will go unchallenged for years, though a careful analysis of the facts may afford no warrant for its acceptance.


1″ David H →
2″ Samuel H →
1 2 3 4 5 6 7 8 9
3″
4″
C = Coloboma D = Dislocation.
A Dot at the right or left indicates the eye affected.
1″ David H.- Blind 30 years before death. Supposed to have Cataract.
2 Sisters and one brother " " " "
2″ Samuel H.- blind 10 years before death " " " "
3″
1919.
1. H.C.H. 64 ?
2. Tillie H. Moore 63 Coloboma both eyes – Cataract both eyes.
3. C.T.H. 61 ?
4. M.R.H. 59. Both Lenses dislocated. ✳ downward.
Under Observation 19 years. Vision Excellent.
5. J.O.H. 55 Coloboma R. Eye. Dislocation R. lens Cataract O.2.
Two Daughters with Coloboma.
6. Sadie H.A. 53. ? Cataract. One Son 6A. Dislocation. O.2
7. S.D.H. 51 ?
8. Lucy H.A. 68 ? Mother of Bertha A. who has Coloboma O.2.
9. Martha T.K. 70 ?
4″
5. A. Miss Jewell H. 23. Coloboma of Left Eye.
5. B Miss Millie H. 25. Large Coloboma of Both Eyes.
6. A. Kenneth A. 30. Dislocation Both Eyes upward.
8. A. Bertha A. 26. Coloboma Both Eyes.
2
4
5
5A
5B
6A
8A

Of the eleven cases referred to above, it is interesting to note that seven occurred in the descendants, in two generations, of one man, and that there is room for a strong suspicion that both he and his father had similar trouble. The

record of this interesting family will be found on the accompanying chart, in which an effort has been made to present the relationship of the various members of the group in as condensed a form as possible.

A number of these patients have been under observation for periods varying from six to twenty years, and as in most instances the lenses have remained clear and in other respects the eyes have been normal, they have afforded an opportunity to study the variations in the refraction of an eye which may be supposed to accompany certain changes in the shape of the lens, apparently resulting from, first, the absence or relaxation of a sector of the suspensory ligament as in coloboma; second, in luxation, the increased rotundity of the lens increasing its refractive power; and third, the astigmatism resulting from the inclination of the axis of the lens, as in its luxation it follows the curve of the lenticular fossa.

To follow and accurately account for all the optical phenomena resulting from slight changes in the lens or its position in the lenticular fossa would demand a degree of skill to which I lay no claim, but a simple record of some of these cases will, I think, be of interest.

Even in the cases of small colobomata or slight subluxation, asthenopic symptoms were not uncommon, and a revision of the refraction from time to time gave marked relief. The degree of accommodative power retained in spite of a large coloboma and marked trembling of the iris was quite remarkable, but when the refraction was accurately corrected, it was still more remarkable to see how much comfort the patient would obtain, and one would be surprised to see how slowly variations in the refraction of the lens took place. The best demonstration of these changes in coloboma of the lens was found in the case of Edward S., mentioned above, which case was first reported to this Society in 1894.

In the H. family, illustrated in the chart, whose members

demonstrate so fully the various possibilities of coloboma and dislocation, there are shown among the younger generation two cases: Miss Jewell H. (5A) and Miss Bertha A. (8A), who, in spite of their well-marked colobomata, have good accommodative power, astigmatism which has remained practically the same since they have been under observation, and, when corrected, practically normal vision. Miss Jewell H. (5A) has been under observation for six years, and her cousin, Miss Bertha A. (8A), for seven years. A third member of this group, Miss Millie H. (5B), has been under observation for some sixteen years, but as she was very young when first seen, the refraction was not accurately worked out at that time, and there seemed to be a degree of amblyopia, the vision with a correcting lens being only 6/15 right and 6/20 left, but after wearing an approximate correction for fourteen years, she was able in 1917 to obtain almost normal vision in each eye: R.E. sph. $-2.00 \bigcirc$ cyl. -2.00 ax. $180° = 5/4-$; L.E. sph. $-2.25 \bigcirc$ cyl. -3.50 ax. $165° = 5/6-$, and this remained practically the same when she was last seen in March, 1919. These three are still young people, and, if I may judge by my experience with other cases, I would be inclined to look forward to somewhat marked changes in the astigmatism of their lenses when they are a little older.

In a few instances, generally rather late in life, opacity has developed in the colobomatous lens, but in most of my cases the truncated border of the lens has been apparently clear and free from evidence of any disease or disarrangement of the lens cells resulting in opacity. While in congenital dislocation of the lens it is not uncommon, as in the case of Kenneth A. (6A in the chart), to find on the lens border the remains of the stretched or ruptured fibers of the suspensory ligament, I can now recall no case of coloboma in which such evidence of a suspensory ligament was to be found, and in the larger colobomata the truncated border, while rounded and thick, was smooth and clear. I fail to understand how, if

our commonly accepted theories of the mechanism of accommodation are correct, we can have the suspensory ligament absent over as much as one-third of the periphery of the lens, and still have only a moderate degree of astigmatism and good accommodative power. This would seem to cast some doubt upon the theory of so-called dynamic astigmatism, due to a contraction of a sector of the ciliary muscle.

In only two of my cases, Tillie M. (2) and Millie H. (5B), in the chart, were the colobomata large, and in Tillie M., aged forty-seven years, cataract was so far advanced when she was first seen that a study of her accommodative power was, of course, out of the question.

It is not difficult to understand how the normal tension on the suspensory ligament can maintain the flattening of the elastic lens of a young person and allow of a fair degree of accommodation in the relaxation accompanying contraction of the ciliary muscle in the presence of a small coloboma, but it would give me great pleasure to hear from some of the members of this Society who have given attention to the problems involved in the physiology of refraction and accommodation as to how, when one-third of the lens periphery is no longer connected with the ciliary muscle, we can still have good accommodative power.

In one case in this family, J. O. H., a man of fifty-five (No. 5 in the chart), we have a small semicircular coloboma of the lower border of the lens, associated with dislocation upward and somewhat advanced cataract. This man is the father of two of the girls mentioned above, Miss Jewell H. and Miss Millie H.

The surprising conditions that may develop in the life history of a case of congenital dislocation of the lens are well illustrated in Mr. M. R. H. (No. 4 in the chart), whose case was described in a paper on "Dislocation of the Lens," read before the Section on Ophthalmology of the Ohio State Medical Association. As he is a member of this family group and

his case is a very unusual one, I will briefly present some of the points of interest which bear on the subject under discussion.

On consulting me in July, 1899, this man had partial dislocation of both lenses downward, and while he stated that he had always been near-sighted, he gave an account of a sudden and very marked impairment of vision following violent exertion. This sudden impairment had occurred in the right eye some four years, and in the left some twenty-four hours, before he consulted me. In the right eye the stretched superior portion of the suspensory ligament could be plainly seen.

Taking into consideration the family history, the account he gave me of the accidents, and the appearance of the eyes, I was of the opinion that I was dealing with a man who, like his nephew, Kenneth A. (6A in the chart), whom I saw two years later, had a congenital dislocation, probably upward, which in his case, by a sudden jar, had been converted into a dislocation downward.

The glasses he had been wearing, R.E. sph.+2.25; L.E. sph.+2 ⊃ cyl.−8 ax. 180°, were evidently given to correct vision through that portion of the lens which remained in the pupillary area, but much better vision was obtained through the aphakic portion of the pupil. This, however, required the use of a strong lens, sph.+15 in the right and sph.+16 in the left, in addition to the correction of his corneal astigmatism, showing that the eyes prior to the dislocation of the lenses were normally hyperopic, but a portion of this hyperopia was neutralized by the increased refraction of the more rotund lens released by the luxation from the restraint of the suspensory ligament. It is also probable that the high degree of lenticular astigmatism was at least in part due to the tilting of the lens.

The recently luxated left lens in this patient was still movable, and by placing him alternately on his back or

having him lean forward with his face down, I could obtain varying states of refraction as the lens was nearer to or farther from the retina, and again on carefully placing his head in the vertical position he could, with proper correction, see well through the crystalline lens, but on shaking his head the lens would fall low enough to enable him to obtain excellent vision over its upper edge.

Both lenses finally settled to a point one or two mm. below the horizontal meridian, and have remained in that position for many years, apparently causing no symptoms of irritation and allowing the patient with proper lenses, R.E. sph. +18.5 and the L.E. sph.+18. ⊃ cyl.+1. ax. 15°, to obtain almost normal vision in each eye. This was in 1903: R.E. 5/6− and L.E. 5/5−, and in 1919 it was with the same lenses R.E. 5/9− and L.E. 5/7.5−.

There is some prominence and slight fading of the iris in the inferior quadrant, at the point where the lens presses it forward, and the pupils are only about 2 mm. in diameter in ordinary light and reduced to 1.5 mm. in strong light and almost straight on their lower borders. A remarkable feature of this case is that with the strong lenses which he has worn constantly for sixteen years he has had practically normal vision for distance with either eye or both eyes in combination, and at the same time reads fine print with ease.

Whether this accommodation is obtained by virtue of the stenopeic pupil alone, or by this in combination with the inclination of the strong correcting lens, as suggested by Dr. Risley, I leave for your decision, but on the occasion of his last visit on April 24, 1919, he had with the right, sph. +20., $A. = \frac{.18 - .51}{.75} = .33$ and with the left, sph.+20 ⊃ cyl. +1. ax. 15°, $A. = \frac{.21 - .50}{.75} = .29$.

The literature of ophthalmology contains many various and curious instances of coloboma and congenital dislocation of the lens, but the phase of the subject which has interested

me most deeply is the sidelight which some of these cases throw on the study of refraction and accommodation. What is spoken of by some writers as dynamic lenticular astigmatism, the form of astigmatism which changes with the act of accommodation, might naturally be supposed to be modified by a condition of the eye in which a relatively large sector of the lens periphery is left entirely without connection with the ciliary muscle, but we are surprised to find that in some of the younger cases not only is there very little lenticular astigmatism, but with the refraction corrected vision and accommodation are practically normal.

The successful study of this subject requires that we should have our cases under observation from time to time for a series of years, preferably from childhood to forty or fifty years of age. Only a few of my cases approximate these conditions, but I hope that some one may be able to follow the future history of certain of these eyes, and we may thus learn from actual observation, rather than by theorizing, what the ultimate effect is when, without other complication, a clear lens goes through its life with a considerable portion of its periphery unattached to the ciliary muscle.

I venture the opinion, subject to correction and revision, that a careful study of the case of Edward S., whose record is continued in the early part of this paper from the account given in my first report in the Transactions for 1894, and those cases of coloboma in the fourth generation of the H. family, as shown on the accompanying chart, will warrant the following conclusion: In youth the elasticity of the lens is such that, in spite of the absence of the zonular fibers over a relatively large sector of the lens, accommodation for that portion of the lens opposite the normal pupil may be satisfactorily accomplished without a marked degree of lenticular astigmatism being apparent, but as the lens gradually becomes rigid with age, an increasing degree of astigmatism of the lens is developed.

DISCUSSION.

DR. W. E. LAMBERT, New York: I have seen a number of cases of congenital dislocation of the lens, and, so far as I have observed, none of them has presented a coloboma of the iris, lens, or choroid. I have operated upon four children, both eyes in each case, and in all the visual result was most excellent. The best vision was 20/20 in each eye, and the poorest, 20/50. The method I employed was repeated discision of the lens. There were no complications in any of the cases. After the absorption of the lens, a clear view of the fundus was obtained, and in all of them it was normal.

DR. A. EDWARD DAVIS, New York: I wish to relate a remarkable case of this kind that came to me with double aniridia and a notch in one of the lenses, which might not be called a true coloboma. It was when the girl was eight or nine years old. The crystalline lenses were clear at that time, and there was no tilting of the lens in either eye. It was interesting to observe the action of the suspensory ligaments in that case, which you could see when the patient made efforts at accommodation; and also the shortening of the transverse diameter of the lens. She was given glasses. I have had her under observation for fifteen years, and it is interesting to note the change in the total astigmatism, though the corneal astigmatism remains stationary. As she grows older, the lens is luxated upward and backward. The astigmatism has increased $2\frac{1}{2}$ diopters, and the patient's vision has been gradually reduced, on account of cataract formation, until now she can only see fingers at a few feet. She is married and has children. One of these also has aniridia.

DR. LUCIEN HOWE, Buffalo: With hereditary defects which are only deformities, we have in one way very little to do. Under such circumstances it is only a question of improving the appearance. But hereditary defects of vision, especially when these defects appear as dominant characteristics, are of decided importance to us all. Thus certain forms of cataract have distinctly dominant characteristics in certain families.

During the present month a meeting is to be held at Cold Spring Harbor of the Eugenics Research Association, at

which questions of this kind are to be discussed. It is our duty not simply to report cases, but to decide what marriages should be prevented or other methods adopted, and then to express an opinion—if necessary, the collective opinion of a society, so that it may have its educational effect on the community, even on legislators, and thus tend ultimately to influence coming generations.

Dr. E. V. L. Brown, Chicago: An important piece of work has recently been done at the University of Wisconsin by Prof. M. F. Guyer. Lenses from albino rabbits were triturated, and suitable quantities introduced into the blood-stream of a rooster, immunizing the fowl's blood to the lens of rabbits. The fowl's blood was then injected into rabbits, and iris colobomas and lens opacities produced. When pregnant rabbit females were so injected, the colobomas and opacities were produced in the litters with considerable regularity.

Dr. Howe: Any one who lives in the country for only a part of the time can verify the heredity of eye defects by breeding experiments. Chickens with congenital coloboma or other peculiarities are especially convenient for that purpose. It happens that just now I have some good examples of similar hereditary eye defects in fowls on a small farm near Buffalo, and would be glad to show the methods of breeding to any of our members who may care to call on me this summer.

Dr. C. F. Clark, Columbus, Ohio: So far as operative work is concerned, I did not go into the question of coloboma and dislocation with reference to that point. What I was interested in was the refraction problem in the cases that have retained clear enough lenses to enable us to follow up the study of the changes occurring in them during a period of years. My conclusion was to this effect: In youth, the elasticity of the lens is such that, in spite of its asymmetry in these cases, there was a reasonable degree of freedom from astigmatism in the central portion, but, as the lens gradually grows rigid with age and this word age is a relative term, an increasing degree of astigmatism seems to develop. That has been the result of my observation in the cases that I could follow for a sufficient length of time, so far as I could arrive at any conclusion.

Fig. 1.—The patient before operation.

Fig. 2.—The patient after operation.

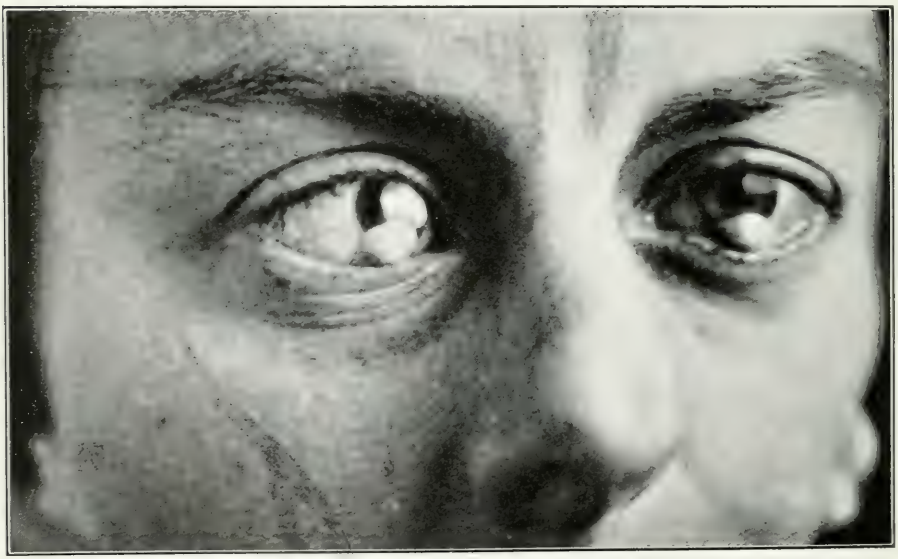


Fig. 3.—An enlarged view of the eye and ear anomalies.

A CASE OF MULTIPLE DERMOIDS OF THE EYEBALL WITH OTHER ANOMALIES OF DEVELOPMENT.

WILLIAM ZENTMAYER, M.D.,
Philadelphia.

Dermoid growths, while not rare, are always of interest. The presence of several such growths associated with other anomalies of development makes this case noteworthy.

W. E. F., aged thirty-two years, single, was seen in my service at Wills Hospital. The personal history records that the facial defects were congenital. She fell from a carriage when two years of age, but spinal curvature was not noticed until seven years later. There is nothing further of note relative to the present condition.

Her grandparents and her parents were not blood relations. In the family of five girls and six boys there are no other instances of deformity, though one brother is feeble minded and has attacks of rotation of the head. The face is of a masculine type, and its conformity is irregular. The forehead is large, the nose is awry, the fissure of the mouth extends on the left side half-way to the ear lobe, the angle being deflected downward. In advance of the lobe of each ear there is a supernumerary tragus. On the right side this consists of a serrated fin of cartilage and skin. On the left side the mass is bilobed and there is a small fistula posterior to it, probably an incomplete supernumerary external auditory canal. Leading from these masses there are contractures of the tissues of the cheek extending to the chin. The palpebral fissures are wide. The right eye squints inward about 25° and upward about 10°.

In the right eye, overlying the sclerocorneal margin below, there is a growth measuring about 5 x 8 mm., and having an elevation of about 3 mm. The axis of the mass is 15°; one-half is upon the sclera and one-half upon the cornea. It

has a pultaceous feel and is of chamois color. The bulbar conjunctiva, from the cornea to the outer canthus in its lower half, is thickened and vascular—probably also a congenital condition.

A second smaller growth springs from the surface of the cornea near its summit. It is somewhat conical in shape and leukomatous in appearance. It measures approximately 4 x 6 mm. and has an elevation of 3 mm. There is a narrow zone of opacity in the cornea about the base of the growth, extending to within 1 mm. of the limbus, from 60° above to 105° below. The corneal tissue is clear over a narrowing band extending around the lower and inner margin of the growth.

The lids cannot be completely closed over the lower growth. There is a very shallow notch in the margin of the upper lid, in a position corresponding to the apex of the corneal tumor. This also is a congenital condition. In the left eye there is a sclerocorneal dermoid almost symmetric with that in the right eye. Its axis is, however, horizontal. In size and color it is identical with the one in the right eye. There is a leash of thickened conjunctiva extending from the lower border of the growth to the lower culdesac. The iris and anterior chamber are normal. The remaining portion of the cornea is clear. Both marginal growths had well-developed white hairs growing from their surface. All three dermoids were removed—the right external rectus was advanced, the internal and superior recti were tenotomized, the supernumerary tragi were removed, and the left macrostomia was corrected by denuding the mucous membrane and removing some of the fibers of the orbicularis oris. Later the faint but large annular opacity resulting from the removal of the corneal growth was tattooed.

The anatomic report made by Dr. Nelson M. Brinkerhoff, pathologist to Wills Hospital, is as follows: The growth from the cornea shows a layer of stratified squamous epithelium beneath which there is a growth of fibroconnective tissue.

The growths from the conjunctiva show externally a layer of stratified squamous epithelium, the cells being keratinized. Beneath this is fibroconnective tissue, with hair-follicles containing hair, acinous glands, fat, and some smooth muscle tissue. Diagnosis: Dermoid tumor.

Dr. Allen J. Smith, of the University of Pennsylvania, made the following report concerning the tissues: "There is no question of the presence of dermoid structures in the irregular section from the corneoscleral border; but I cannot be sure of any unquestioned dermoid formation in the round sections from the lesion of the cornea proper. There are a series of tubes in it which are in part blood-vessels and lymph-channels, and the former should not be in the cornea. Now some of these channels with a marked cellular accumulation inside of them might, by bare possibility, be much altered oil-glands of the skin, but they are certainly not clearly of such a nature, to my way of thinking. In fact, I doubt whether any of them are such structures—and these are the only things suggesting a dermoid factor in the latter growth."

As the physical examination of the patient revealed the heart on the right side of the sternum, the chest was *x*-rayed by Dr. Henry Pancoast, of the University of Pennsylvania, who reported that the chest plates confirmed the marked scoliosis and showed marked rotation of the vertebræ. This placed the heart entirely on the right side, and would indicate an acquired dextrocardia with rotation of the heart to the right side.

In the *American Journal of Ophthalmology*, January, 1919, Stark reports a case of congenital tumor of the cornea which is clinically identical with the corneal condition of my case. Microscopically the epithelium was of a different arrangement and fat was found at the base of the growth.

In Stark's paper may be found a review of the literature bearing on dermoids of the eyeball and a full discussion of the pathogenesis and classification of congenital tumors of the cornea.

Regarding the tumor situated wholly upon the cornea, in which no histologic elements of the skin were found, it may be pointed out that, according to Stark, Saemisch and others have called attention to the great variability of the histologic components of these growths, especially of the subcutaneous fatty cellular tissue, which may be merely

suggested or may form the main bulk of the tumor. Saemisch does not, therefore, think it justifiable to select this factor as a criterion for classification, but deems it more appropriate to base the classification upon their topography.

Stark concludes that the term dermoid may be used to classify congenital tumors, even those of simple histologic structure containing no dermal tissue, hairs, or sweat-glands.

TUBERCULOSIS OF THE RETINA.

EDWARD JACKSON, M.D., AND (by invitation) WILLIAM C. FINNOFF, M.D.,
Denver, Colorado.

Not many cases of this condition will be seen by any one observer; and only a minority are well suited to ophthalmoscopic study. The only way to fill out the ophthalmoscopic picture of this important disease is by placing on record such cases as may from time to time prove available for prolonged ophthalmoscopic observation.

It is important too that such records be made to include, both in description and in pictorial representation, so far as possible, the minute details that tend to throw further light on the great field of ophthalmoscopic pathology. There is reason also to present additional evidence that the group of cases here referred to really represent an important form of ocular tuberculosis; and that their study may help to a better understanding of the tuberculous process in general. Such considerations seem to justify this report.

The following case is of value because a study of the early lesions of tuberculosis of the retinal vessels could be made, and because the case has been followed over a period of two and one-half years, during which time the disease in the right eye progressed through the various stages even with tuber-

culin treatment, while the condition in the left eye was held under control and is apparently cured.

Case I.– L. E. B., male, aged twenty-eight years (patient of W. C. F.), rancher by occupation. Had chicken-pox when a child. When twelve years old had a severe attack of influenza. Since that time has enjoyed the best of health. Denies having had venereal diseases. Has not had a chronic cough or lost weight recently. Three years ago complained of symptoms of eye-strain, for which glasses were prescribed, which gave relief. Family history good. Some time in October, 1916, his eyes became very red and painful, but with no marked photophobia or lacrimation. Noticed that when rising suddenly from stooping posture saw yellow and gray spots to the periphery of the visual fields. There was no conjunctivitis at the time. This lasted about ten days, and gradually cleared up until he was apparently well. The eye was not treated at that time. Shortly after this attack he came to the city and was employed as a bookkeeper.

November 15, 1916, the eyes became painful and red. Photophobia and lacrimation became so severe that it interfered with his work. The symptoms rapidly increased in severity until it was only with the greatest effort that he was able to keep his eyes open.

He consulted one of us (Dr. Finnoff) November 17th complaining of severe photophobia, profuse lacrimation, and ocular pain. V.R.E., 6/6; L.E., 6/6. There was marked circumcorneal injection of both eyes. The right cornea had two deeply located, fine, oval, grayish infiltrated areas in the upper temporal quadrant. They were 2 mm. from the limbus. The upper opacity was 1 mm. in diameter and was the denser. The lower was 1 mm. in diameter and was separated from its fellow by 1 mm. of clear cornea. The left cornea had two opacities in the lower temporal quadrant, which were larger than those in the right cornea, and two small ones, pinpoint in size in the pupillary area. The infiltrates were grayish in color, and did not stain. No blood-vessels were present in the cornea (Fig. 1).

The pupils were dilated with atropin, and the ophthalmoscope revealed the following: Right eye: The margin of the optic nerve was ill defined. Two oval patches, about

one-fifth disc diameter in size, of grayish exudate, one covering the superior nasal vein and the other the superior nasal artery, were seen near the margin of the nerve-head. Two similar patches could be seen covering the first upper branch of the superior temporal vein and were about one-half disc diameter apart. The intervening portion of the vein was slightly constricted. The vein was not markedly distended distally to the infiltrations. Because of the marked photophobia the examination was discontinued. Left fundus was negative. Atropin and 5 per cent. dionin, to be used locally, and calomel internally, were prescribed, and a subcutaneous injection of old tuberculin was given. A thorough physical examination was made, and at this time nothing abnormal was found.

Fig. 1.—Right eye, showing corneal lesions which brought patient under observation.

November 20th: Pupils dilated and lacrimation less. No changes in corneal opacities. Fundus examination revealed in the right eye numerous small patches of exudate covering the retinal veins. The veins were somewhat distended, and near several of the exudates they were irregular. All patches were to the temporal side and in the periphery. Report from dentist negative. Wassermann negative. Urine negative. X-ray of chest, teeth, and nasal sinuses negative.

November 22d: O. D.: No change in corneal opacities. Increase in number of retinal exudates and those that were formerly present have increased slightly in size. O. S.: No change in cornea. There is a slight haziness over the inferior temporal vein which is slightly irregular. These changes are apparently a focal reaction to the tuberculin which was

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TUBERCULOSIS OF THE RETINAL VESSELS.

given November 15th. There was also a local but no constitutional reaction to tuberculin.

November 26th: Corneal opacities not as dense as when last seen. Fundus much the same.

December 2d: V.R.E., 6/12; L.E., 6/15. Corneal opacities showed slight improvement. The right fundus presented two large patches of exudate on the temporal side near the equator: one was about two-thirds size of the disc, yellow, and covered the vessels, the other was lower, one and a half times the length and one-half the width of the disc, had irregular edges and was yellow. There were two new opacities, one-fifth disc diameter in size, covering the lower temporal vein (Figs. 2–4). In the left eye four small patches covered veins in the periphery of the fundus. The veins in the vicinity of the exudates were irregular.

The patient at that time recalled having in his herd a suspected tuberculous cow from which he received his milk. Thinking there might be a possibility that this was the bovine type of tuberculosis, a 1/2000 mg. of bovine tuberculin was injected subcutaneously on December 5th.

December 8th: V.R.E., 6/30; L.E., 6/30. In the right eye along the lower temporal vein, between the patches of exudate, a small hemorrhage was seen. There were several new patches of exudate in the left fundus all far anterior (Fig. 3). These changes were believed to be a reaction to the tuberculin which had been injected December 5th.

December 10th: Vision same as before. Another small hemorrhage near a vein in the upper part of the right eye: corneal opacities were very much improved.

December 12th: Fundus picture much the same.

December 16th: V.R.E., 6/30; L.E., 6/30. Corneal opacities were very much smaller and only seen with condensed light and corneal loupe. In the right fundus the larger patches of exudate had disappeared and had been replaced by smaller hemorrhages (Figs. 4 and 5). There were other small hemorrhages in the region of the patches of exudate. There were no massive hemorrhages or vitreous haze. The left fundus showed little change from last examination.

December 24th: Two small pin-point opacities were still present in the right cornea. For several days the vision had been more blurred in the morning and cleared during the

day. V.R.E., 6 7.5−1. The right fundus remained about the same. V.L.E., 6 10. The left cornea clear, no patches of exudate. To the nasal side of the fundus the lesions along the vessels had disappeared, but one large patch still remained on the temporal side far forward. Tuberculin 1 50000 mg. was injected subcutaneously.

December 28th: V.R.E., 6 12−3; L.E., 6 5. Three small opacities were still present in the right cornea. The right fundus showed marked changes. There were numerous flame-shaped hemorrhages surrounding the veins distally to the opacities. The whole venous system was more congested and the vitreous was slightly hazy. In the left eye three small corneal opacities were again noted, but the fundus showed no change since the former examination.

January 8, 1917: There were numerous flame-like hemorrhages scattered over the temporal side of the right fundus. In the upper temporal region the hemorrhage had increased greatly in size and obstructed a view of the vein. In the lower temporal area a whitish band could be seen which resembled the beginning of a retinitis proliferans. The left fundus showed changes also. The large patch of exudate that was seen at the former examination had disappeared, but on the lower temporal vein, quite far forward, several streaks of exudate had made their appearance. Tuberculin 1/300000 mg. subcutaneously.

January 11th: V.R.E., 6/12; L.E., 6/6+. Corneæ were clear, but fundus picture was about the same. No focal reaction from the tuberculin.

At this time the man who had been looking after the patient's ranch left him, and it was necessary for him to return to care for his cattle. He took his tuberculin with him, and had his local physician administer it, and said that, from time to time, he would consult an oculist who was located nearer to his home. He was not seen again until April 7, 1917.

During his absence a supposedly abscessed tooth was removed and the nasal sinuses were opened with the hope of removing focal areas of infection. After the operations the vision seemed gradually to improve until April 6th, when he noticed that there was a dark line in his lower temporal field, which increased in size during the day and finally in-

cluded the lower nasal field also. Early in the day he noticed a small stellate black spot in the center of the visual field which was rapidly replaced by a uniform central haze. He had not been doing any unusually strenuous work prior to these changes. We could find no external cause for it. His tuberculin had not been given regularly during his absence.

He was seen again on April 7, with V.R.E., 5/15, L.E., 5/5. There was a small oval infiltration in the pupillary area of the right cornea similar to those that were present earlier in the disease.

A large subhyaloid hemorrhage was present in the upper one-fourth of the fundus, another large hemorrhage was present in the region of the disc, and two smaller ones to the nasal side of it. These were best seen with a +7.00 lens. The disc was not visible, its view being obscured by the hemorrhages and the hazy vitreous.

April 20th: The left cornea was clear and the only change in the left fundus was a slight variation in the caliber of the lower nasal vein. 1/300000 mg. tuberculin was given and was not followed by a reaction. The large hemorrhage seen at the last examination was almost entirely absorbed.

May 5th: V.R.E., 5/20; L.E., 5/5+. A few strands of connective tissue could be seen in the lower temporal side of the right fundus, which is the first sign of a retinitis proliferans; the vitreous was not so hazy, and the disc outline could be faintly seen.

In the left vitreous a small mossy floater was seen and on the extreme anterior portion of one of the branches of the upper nasal vein some patches of exudate were present. The nerve was red and its edges were hazy. 1/250000 mg. of tuberculin was given subcutaneously.

May 7th: V.R.E., 5/30; L.E., 5/5−2. No other changes in fundus.

May 19th: Tuberculin 1/200000 mg. subcutaneously. V.R.E., 5/60; L.E., 5/5+. Right eye hazy to temporal side of fundus. More strands of connective tissue below. Left fundus no pathologic changes seen.

May 21st: No changes since May 19th.

Patient was seen again June 4th: V.R.E., 3/60; L.E., 5/3. There was no marked change since last observed. 1/175000 mg. of tuberculin given.

The patient was last seen July 9, 1917, and at that time he showed the following: V.R.E., 5 60+; L.E., 5 4. The strands of connective tissue below and to the temporal field were getting whiter, but no other changes were observed.

During Dr. Finnoff's absence on military duty the patient consulted Dr. Jackson on September 24, 1917, and the following conditions were noted: V.R.E., 0.08; L.E., 1.4. Right eye, some fundus reflex in all directions. General haziness of vitreous. No fresh hemorrhages. Large masses of connective tissue, getting white, avascular below and to disc.

March 8, 1918: The eye improved until two weeks ago, when the image of an object regarded seemed distorted and since has appeared clouded. Attributed to pitching hay.

September 14, 1918: One hemorrhage the last of July, which has cleared up. V.R.E., 0.2+, L.E., 1.4. Vision of the right eye best when looking eccentrically to the right (temporal field).

Ophthalmoscope: Right eye. Strands of white tissue and haze in lower nasal quadrant. Upper temporal quadrant almost normal to the periphery. Disc and macula not seen. Some opacity far forward chiefly on nasal side. Left disc red.

June 22, 1919: W. C. F. V.R.E., 0.33; L.E., 1.4. The vision of the right eye has been steadily improving since he was last seen. With the ophthalmoscope several bands of retinitis proliferans were seen in the right fundus (Fig. 6). They were brought into focus with a +6.00 or +7.00 D. lens. Between the bands of scar tissue the fundus is normal. The retinal vessels are normal in size, are not tortuous, and show no evidences of perivasculitis or other involvement. The left fundus is normal, and no sequelæ of the disease were found in this eye.

Comment: In this case tuberculosis of the retinal vessels would not have been detected until after hemorrhages were present and vision materially lowered if it had not been for the corneal involvement, which caused the photophobia and called the patient's attention to his eyes. Doubtlessly many of the cases of massive hemorrhage into the vitreous have the same lesions of the retinal vessels, but attention is not attracted to the eyes until the vision is disturbed.

With the history of the patient's drinking milk that was obtained from a tuberculous cow, and with the marked focal

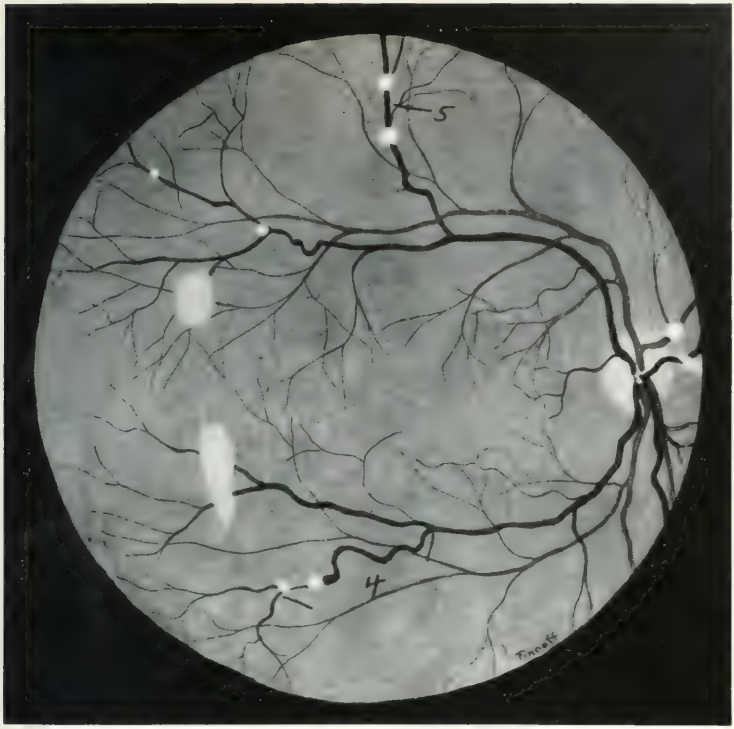


FIG. 2.—RIGHT FUNDUS, DECEMBER 2, 1916. THE 4 AND 5 INDICATE PORTIONS SHOWN IN DETAIL AT A LATER DATE ON COLORED PLATE XVI.

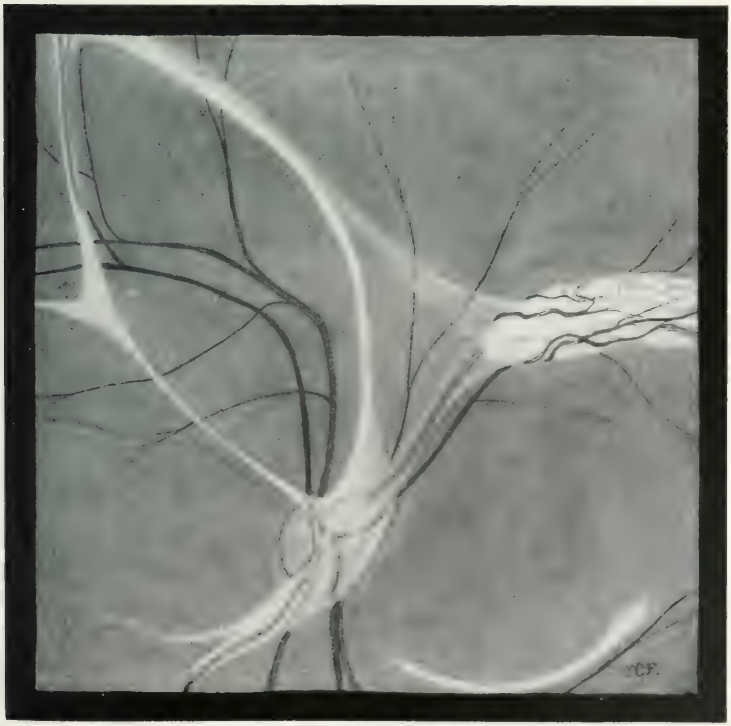


FIG. 6.—BANDS OF RETINITIS PROLIFERANS IN RIGHT EYE, AS SEEN TWO AND ONE-HALF YEARS AFTER ONSET OF THE DISEASE.

reaction after the administration of bovine tuberculin, it seems probable that the condition was the result of an infection with bovine tubercle bacilli.

The retinal involvement began as a perivasculitis and with only one exception (Fig. 2) the areas of infiltration were confined to the perivascular spaces of the veins. But, as the disease progressed in the right eye, the walls of the vessels became involved and a true phlebitis occurred (Fig. 4).

The necessity of using very small doses of tuberculin both for diagnostic and therapeutic purposes is illustrated in this case; for with as small a therapeutic dose as 1 50000 mg. a marked focal reaction apparently took place, and caused the changes which were seen in the right eye December 28, 1916. The following dose was decreased to 1 300000 mg. and the subsequent doses were very cautiously increased with no further serious reactions.

Tuberculin apparently had a beneficial action on the left eye in this case, for it was started when the retinal lesions had first manifested themselves in that eye and they disappeared shortly after their appearance. It is also possible that it had a detrimental influence on the right eye.

CASE II.—R. B. T. Clergyman (patient of Dr. Jackson), aged thirty-three, when he came in 1906 for a change of the glasses he had been wearing for six years. For four years he had noticed distant vision growing indistinct, and his lenses were found insufficient to correct his compound myopic astigmatism. He required R.E.: sph. $-2.50 \supset$ cyl. $+1.50$ ax. 67° $=1.1$. L.E.: sph. $-2.50 \supset$ cyl. $+1.75$ ax. 95° $=1.1$. Both 1.2.

September 27, 1911: His vision had again grown indistinct from a slight increase in the myopic astigmatism and change in its meridians. His new correcting lenses again gave V. $=1.2$.

January 25, 1916: He had lost much sleep lately, and noticed muscæ, and the lids felt "granulated." Venous hyperemia and papillary roughening of the palpebral conjunctiva were present. V. $=1.1$ in each eye. Ointment of yellow oxid of mercury, 1:180, and rest from reading gave relief.

December 5, 1916: He had lately noticed muscæ before left eye and required a slight change of the left lens, which

again gave relief. L.E., sph. $-3.00 \bigcirc$ cyl. $+2.00$ ax. $100^\circ = 1.1$. His accommodation was 5 D.

It is probable that more complete ophthalmoscopic examination at this time would have shown some retinal lesions in the upper fundus. This patient had come to Colorado in 1900 and had suffered from obscure pulmonary symptoms, poor general health, and tuberculosis of the testes, which were removed three years later.

February 9, 1917: A spot before the left eye has been growing worse. His corrected vision is only 0.5.

Ophthalmoscope: L.E., pupil dilated with homatropin. Media clear. The macula shows 20 or more, rather faint, grayish white spots, arranged in lines radiating from the fovea. The retinal veins are all somewhat dilated and tortuous, but especially the upper temporal vein and its branches. In the upper temporal retina are many small flame-shaped hemorrhages. These begin two disc diameters from the disc, and extend up and forward to the periphery of the visible fundus.

He was referred to Dr. C. N. Meader, who found slight roughening of the respiratory sounds and dullness at the apices, which he took to be evidence of an old lesion; no other evidence of active tuberculosis.

February 19th: He received 1/10 mg. of old tuberculin. This caused a distinct general reaction, including disturbance of blood-pressure and nausea, which was taken to indicate an adrenal lesion. There was no objective evidence of a focal reaction in the eye. Vision was unchanged, except that he complained that a distortion of objects seen with the left eye seemed slightly increased.

March 5th: Began use of 1 100000 mg. bacillus emulsion once a week, gradually increasing the dose.

March 16th: About twenty-two hours after an increased dose of tuberculin the optic discs looked slightly redder, and he noticed more distortion of objects with this eye than before the dose was given.

April 3d: After receiving tuberculin yesterday he noticed more distortion. "Things looked drunk and compressed laterally." V. $= 0.5$.

April 12th: V. $= 0.7$. The white spots in the macula are much more distinct than they were two months ago. There

are remains of several hemorrhages in the upper retina, the region directly above the disc being more involved than at first. Some of the veins are obscured at the crossings.

May 3d: V. = 0.6, but was worse after the last dose of tuberculin, nine days ago.

July 2d: V. = 0.7. Could not rest as much as he wished lately. Vision "confused" since he had two tuberculin injections with only a week interval. After this a two weeks' interval was allowed.

At this time the white spots in and about the macula were most numerous—50 or 60—and very sharp and distinct. Small hemorrhages still occurred, but they were getting less numerous. The upper temporal retina was hazy, but other portions remained normal. After this all the appearance of retinal disease gradually diminished.

December 3, 1917: 1 10 mg. had given pain in the elbow for the last two months.

January 28, 1918: There are still about 15 small white spots in the upper nasal quadrant of the macula, none of them now as large in diameter as the largest retinal artery. The upper veins are still large and tortuous. The haziness of the retina has almost or quite cleared up. There are no hemorrhages.

October 23d: The retina above the disc is hazy and swollen, and two small, indefinite, flame-shaped hemorrhages are found. The veins of this region are rather large and slightly tortuous. The macula appears quite normal. V. = 1?

November 22d: The retina above the disc has cleared up. The vessels all appear normal. R.E., sph. $-2.25 \supset$ cyl. $+ 1.25$ ax. $80^{\circ} = 1.1$. L.E., sph. $-3.00 \supset$ cyl. $+ 2.50$ ax. $103^{\circ} = 1$. The left eye has continued normal. The right eye has not been affected at any time. At no time was the patient's general health much impaired. Apart from the tuberculin reaction there was no fever, and while under treatment he gained eleven pounds in weight. He continued leading an active, rather strenuous outdoor life in the care of his large mountain parish between 6000 and 8000 feet above sea-level.

CASE III.—Male, aged twenty-five, while studying hard for the priesthood two years before, and in poor health, lost

the sight of his left eye from vitreous hemorrhage. In February, two months later, his eye was well. In March the right eye became blind from the same cause, but it had recovered in August. In September the hemorrhage started again. In June last he had been put on the use of tuberculin and his sight in both eyes had cleared so that he could read. Then the right rapidly grew worse, and he was sent from eastern New York to Colorado.

December 19, 1917: V.R.E., moving fingers at one foot in the extreme temporal field. L.E., with cyl.+0.25 ax. 170° = 1.1.

Ophthalmoscope: Right eye under atropin; cornea and lens clear, vitreous clouded, no fundus details visible. There is a grayish-red reflex in all directions. In the lower temporal portion of the vitreous floating masses can be seen which look almost like detached retina, but no vessels are found. Left eye, slight haziness of vitreous. Choroid rather patchy and "moth-eaten," but optic disc and retinal vessels are normal.

Locally hot stupes and atropin were employed for the right eye, and he was referred to Dr. C. N. Meader, who found an infiltration of the apices of the lungs, especially the right. He was put on the general treatment and regimen for tuberculosis, but without tuberculin treatment.

January 18, 1918: The right eye shows a yellowish-gray reflex, without details, over the whole fundus, except the anterior nasal portion, which is dark. He has gained three pounds in weight.

February 1st: The anterior nasal portion is clearing. V.R.E., 1/500.

February 15th: A fresh hemorrhage occurred in the lower portion of the vitreous, noticed as a black mass in the upper field of vision and increased haziness.

April 5th: There was another fresh hemorrhage seen as a black mass in the lower vitreous.

May 3d: There were some whitish masses in the vitreous up and out, and a fainter red reflex in other directions. No vessels visible on the masses. His general condition is better, and he can walk five miles without feeling fatigue.

June 6th: V.R.E., 0.002. A whitish mass in the vitreous showing fine vessels is seen with a 12 D. lens, and masses of

vitreous opacity are noted toward the periphery of the fundus.

August 15th: V.R.E., 0.004. Ophthalmoscopic findings about as before.

January 29, 1919: Right eye: There is a dense general haze of the vitreous, permitting a moderate reflex. But no fresh hemorrhages since last noted. V. = 0.005.

V.L.E., 1.2. Fundus normal, but one distinct linear opacity in vitreous to nasal side of the center.

Cases Previously Reported.— Regarding the cases previously reported, it is of interest to note that the patient whose fundus condition was illustrated in plate facing p. 579, vol. xiv, of the Transactions of this Society, has remained in good health, with practically no change in retinal condition since that time; corrected vision 0.8 when last examined.

Mrs. W. R. L., whose case was alluded to in vol. xiv, p. 502,* after months of recurring hemorrhages had recovered, V.R.E., 0.06, L.E., 0.4, and seemed in good health for three months after the birth of her child, but gradually lost weight and felt less well.

March 6, 1916: Her vision was R.E., 0.06; L.E., 0.4. Six weeks later she noticed some disturbance of vision.

April 28th: V.R.E., 0.06, L.E., 0.15. The ophthalmoscope showed decidedly increased clouding of the vitreous, but no fresh hemorrhage.

May 1st: A fresh hemorrhage occurred the evening of April 29th, in the left eye. Vision was reduced to perception of hand movements. The hemorrhage was located in the temporal part of the vitreous. To the nasal side the fundus reflex was good and there were whitish masses well forward (25 to 35 D. of H.).

May 15th: The left eye gradually improved, the vitreous clearing. V. = 0.07.

May 22d: Two days ago a fresh hemorrhage occurred in the right eye, which showed general haze of the vitreous and V. = moving shadows.

* Detailed report Trans. of the Colorado Ophthalmological Congress, 1915, p. 203.

May 29th: V.L.E., 0.2. It was worse again six days ago, so that she had to be led around.

June 20th: Sight was better until eight days ago, then worse; since then clearing. Now V.R.E., 0.002; L.E., 0.1.

July 27th: Feels the heat, appetite depressed. Sight began to improve after fresh hemorrhage three days ago.

August 25th: V.R.E., 0.012, L.E., 0.05.

September 25th: Fresh clouding three weeks ago. Has improved since. V.R.E., 0.012; L.E., .005.

February 13, 1917: For four months she has lived out-of-doors, gained weight and strength. V.R.E., 0.06; L.E., 0.35.

March 8th: V. has dropped to 0.1 in the left eye, the better one, with fresh clouding.

March 31st: V.R.E., 0.012; L.E., 0.003.

May 23d: Sight has steadily improved. R.E., 0.012; L.E., 0.25.

November 27th: There was a new hemorrhage in July and after that steady improvement. V.R.E., 0.014; L.E., 0.4.

January 8, 1918: Had some disturbance of vision three weeks ago, but no evidence of fresh hemorrhage. V.R.E., 0.01; L.E., 0.4.

January 18th: Sight seems worse, V.R.E., 0.01; L.E., 0.4. She was again put on tuberculin, which had been discontinued for fifteen months.

February 16th: There has been aching about the right ear, and a fresh hemorrhage into the vitreous of the left eye. V.R.E., 0.012; L.E., moving objects.

March 11th: She again returned to the farm in South Dakota.

For about two years the discs and most of the fundus in both eyes have been invisible. When the vitreous was clearest, white masses of retinitis proliferans could be seen.

From the cases now reported it appears that retinal tuberculosis begins by the appearance of white infiltrates in front of certain retinal vessels, most frequently the veins. Later these particular vessels show all the signs of perivasculitis, and the affected portions of the veins may be greatly altered in caliber. At this stage hemorrhages occur and the patient

is likely first to come under observation for impairment of vision.

The hemorrhages may be comparatively small and confined to the retina throughout the course of the disease, clearing up in the end, so as to leave no trace visible with the ophthalmoscope and good vision. In other cases the hemorrhages are massive, pushing off the vitreous or bursting into it, and are followed by the well-known picture of retinitis proliferans and great permanent impairment of vision.

In many cases in which the eye-ground remains visible throughout white dots resembling those seen in renal retinitis are formed in the macula, causing impairment of vision, but less than their appearance would lead us to expect, and subsequently clearing up entirely.

Often both eyes are affected in the beginning, but one may remain only slightly involved, and recover completely, while the other is greatly and permanently damaged by hemorrhage.

The course of retinal tuberculosis is more protracted than that of other diseases likely to cause some of the same ophthalmoscopic symptoms.

Cases not attended with pyrexia or extensive active tuberculous lesions in other parts of the body do well on small doses of tuberculin given at intervals of at least one week; and all cases require the general regimen and treatment for combating tuberculosis.

DISCUSSION.

DR. ARNOLD KNAPP, New York: These cases of retinal tuberculosis—periphlebitis, so called—that Dr. Jackson has now put on record, and has so beautifully illustrated, bring up a number of questions. I should like to ask, in regard to his first case, how he explains the presence of the deep corneal lesions. It has always seemed to me characteristic of a tuberculous process that the manifestations are either in the anterior or in the posterior part of the eye; in other words,

if you have retinal periphlebitis, you usually do not have lesions in the anterior part of the eyeball.

In the second case, if I understand correctly, the star-shaped macular figure developed. That has always been associated, in my cases, with an exudate into the retina, irrespective of the etiology. I should like to know whether an exudate was present in this case. The figure disappears, but some macular changes remain, and the vision is, consequently, diminished.

In regard to the third case, which I had under my care at one time, I should like to ask Dr. Jackson whether he is optimistic with the result of tuberculin treatment in preventing a recurrence of these retinal and vitreous hemorrhages.

DR. C. D. WESCOTT, Chicago: I wish that Dr. Jackson would tell us his present method of using tuberculin -the dosage, etc., especially when he continues the treatment over so long a period of time as he has mentioned in one of these cases.

DR. H. M. LANGDON, Philadelphia: The subject of tuberculin in the treatment of ocular tuberculosis recalls the case of a young girl, sixteen years of age, who came complaining of blurring of vision in the left eye. There was a slight haze in the vitreous, and a well-defined patch of exudate in the retina, about half the size of the disc, below the macula. She had been apparently in perfect health, but physical examination and the *x*-rays showed a well-advanced apex tuberculosis. She gave a positive tuberculin reaction. On account of the lung involvement it was deemed unwise, for the time being, to use tuberculin; and she was placed on the ordinary hygienic measures proper in such a condition. With these, in six weeks the ocular condition entirely cleared up, leaving nothing but a small, poorly defined scar in the retina. Vision was 6/5. Some of the cures that are attributed to tuberculin may be due to the systemic measures taken, as well as the general reaction produced by the tuberculin; and I should like to ask Dr. Jackson whether he thinks that tuberculin does all the good that we attribute to it in these ocular cases.

DR. EDWARD JACKSON, Denver: The third case, as Dr. Knapp correctly surmised, was the case that he had seen,

and in which, I think, he instituted tuberculin treatment. I was not able to get the details regarding the early history. That man has apparently recovered. He was under a pretty strict regimen when he first came to Colorado, but that has been gradually relaxed. He was later allowed to play tennis and take walks, and gradually to play longer and walk greater distances. Then he was permitted to resume his studies; and finally, a few weeks ago, the question came up as to whether he could come East for about six weeks to complete his studies to enter the priesthood. I advised him strongly against it. I said that while he was relatively in good health, his continuance in good health remained dependent upon his observing the conditions under which he had attained it.

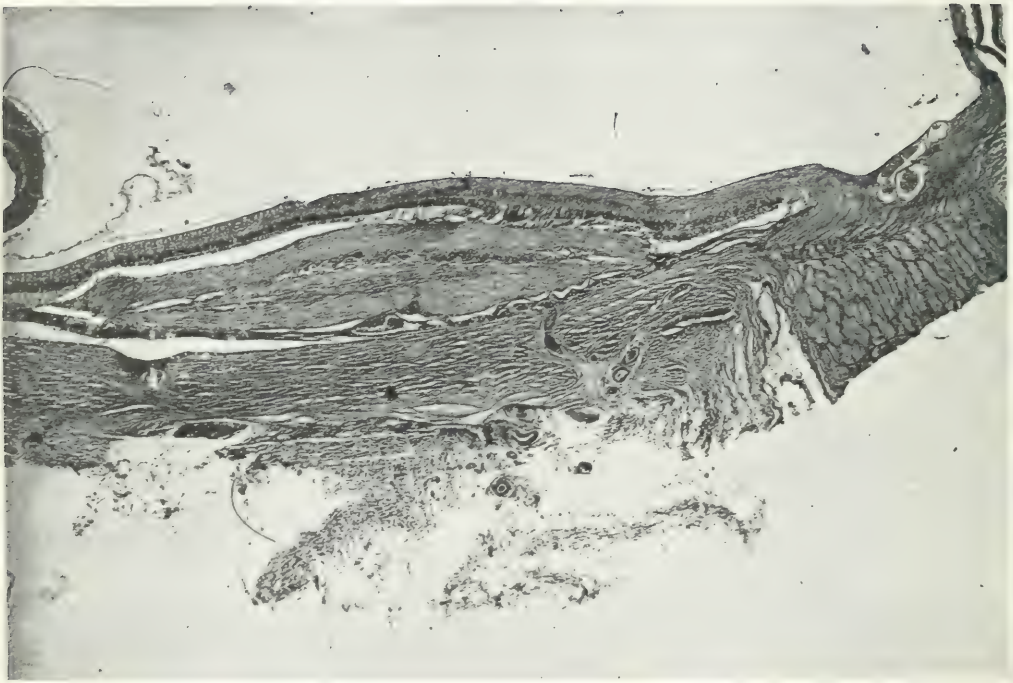
That might bring up the matter of the value of tuberculin in these cases. As will be noted, we concluded that the regimen, the life, or the general treatment of tuberculosis should be observed in every case; but that tuberculin should be reserved for those cases that are free from decided temperature changes. A variable temperature curve, dropping each day below normal, though not going much above it, may have the same significance as a distinct daily rise in the temperature. Concerning those who are free from this, and have no large evident tuberculous lesion in the lungs or elsewhere, it is wise to give the 1 100000 or 1 500000 milligram. This treatment is not applicable to a patient with large tuberculous deposits. If the patient is free from them, my impression in the few cases I have been able to follow is that the ocular lesions did better and came to a final cure under tuberculin, when they did not without it. The tendency to relapse is the final test of relative cure that is brought about by the tuberculin. It occurs several times under the long administration of tuberculin.

With reference to the method of administration, I would say that I have always had the assistance of an internist in all the cases I have reported. Dr. C. N. Meader saw those that I referred to to-day. I am certain of the importance of small doses at long intervals. One of these cases began the therapeutic use of 1 500000 milligram, repeated at intervals of a week. Another was getting a somewhat larger dose, but when the dose was raised to 1 10000 milligram, or

more than that, he seemed to do rather badly. The interval was lengthened, and the dose dropped back.

The present state of our knowledge of the action of tuberculin is experimental, and every case should be watched as an experiment; but the things that stand out most clearly in my mind are that the doses should be small (not to give a trace of reaction is better than to give a big reaction), and that the intervals should be long. Tuberculin, if it does good, does so by starting a certain reaction in the system, and, until that reaction has time to occur and be complete, the dose should not be repeated.

With reference to the question of the corneal lesion, I would state that this is the only case that I have seen in which there were distinct lesions in the anterior segment that were followed by retinal tuberculosis; but in this instance the connection seemed pretty definite. I have seen, in one other case, at the first examination of the patient, not very early in the case then, marked vitreous exudates, entirely free from any connection with the retina, there being apparently no diseased tissue between them and the retina. They were far forward in the vitreous. I suspected that there had been lesions in the anterior segment. This is the only case in which I have seen them.



SUBRETINAL EXUDATE SIMULATING SARCOMA OF THE CHOROID, WITH ANATOMIC EXAMINATION.

ARNOLD KNAPP, M.D.,
New York.

Eyes have been removed on account of a presumptive sarcoma of the choroid and have shown, on microscopic examination, an organized subretinal fibrous exudate. It seems of interest to put on record another case of this kind and to study the ophthalmoscopic changes with the view of determining whether these changes are definite enough to help in avoiding similar diagnostic errors.

Case History.—P. C., aged seventy-one, presented himself at the Herman Knapp Memorial Eye Hospital on December 20, 1916, stating that the sight in the right eye had been failing for four months. The left eye was poor for some years. V.R.E., 1 200; L.E., 10 200. Patient seemed rather emaciated, but otherwise healthy. Urine showed a trace of albumin and a few granular casts; the heart was negative; blood pressure, 150-80. Wassermann negative. After dilating the right eye, there was a sharply circumscribed detachment of the retina just in the macular region. This area seemed to be occupied by a solid subretinal mass, which was dull white in color, except in the center, where there was some irregular mottling. It showed an elevation of 3 D. The outlines were sharply limited. Diagnosis of sarcoma of the choroid was made and the eye was enucleated.

The microscopic examination of the enucleated eyeball showed in the macular region, between the choroid and the retina, directly springing from the choroid, a triangular mass which consisted in the periphery of organized connective tissue, while in the center the tissue was of a more homo-

geneous structure with fewer cells. Running through the center of this mass there was an irregular line of pigment, evidently the pigment epithelium, with numerous gaps and a number of proliferated pigment cells extending into the surrounding tissue. The retina was adherent to this mass; the rods and cones could not be identified; the outer granular layer was scanty, with the radiating supporting fibers unduly prominent, being thickened and stretched, often containing amorphous masses. The blood-vessels in the retina showed no change, and the central vessels in the nerve-head appeared normal. The choroid itself seemed normal, except for distended vessels whose walls were normal, without perivascular cellular infiltration. The mass was directly adherent without being continuous in structure, the character of the tissue changing immediately to flat, riband-like connective-tissue fibers, like hyaline corneal tissue, with occasional poorly staining round and spindle cells, and amorphous tissue without any particular characteristics. There were occasional blood-vessels in the mass. To each side of the mass the separation between pigment epithelium and retina was continued by a granular amorphous exudate lined with pigmented cells.

Subsequent History.—On August 28, 1918, the patient returned, complaining that the sight in the left eye had grown worse. The sight was found reduced to counting fingers at six feet, and after dilating the pupil the eye-ground presented, in addition to an inferior conus, the following changes in the macular region: On the nasal side there was a triangular, deeply placed hemorrhage; adjoining this there was an area of superficial choroidal atrophy. On January 6, 1919, the condition had somewhat changed, inasmuch as some dark pigment had replaced the deep hemorrhage and there were two fresh, deep-seated hemorrhages, one above and one below the original area. The patient was again seen on April 15, 1919, and showed, in addition to the pigment and deep hemorrhages in the macular region, chorioretinal changes with deep hemorrhages, connective-tissue formation, and sclerosis of the choroidal vessels.

To recapitulate, the mass which was taken for a sarcoma of the choroid, on histologic examination, proved to be composed of fibrous tissue presumably the result of either an

organized exudate or of a blood-clot. The choroid showed no inflammatory infiltration. Its vessels, as well as those of the retina, were normal.

A case which resembles this closely is that of R. Beatson Hird,* who reported the case of a woman, aged sixty-four, in whom the macular region was occupied by a circular, pale, yellowish-white area, elevated 4 D. The edges were sharply defined; a prolongation extended from one part toward the periphery and three hemorrhages were present in the surrounding retina. The retinal vessels seemed normal. The diagnosis of sarcoma of the choroid was made and the eye was enucleated. The microscope showed a tumor not connected with the choroid, consisting in a mass between the retina and pigment epithelium made up of fibrous coagulum and organized blood-clot, with extension of epithelial cells into the mass from the pigment epithelium and fissures from cholesterin deposits. A committee consisting of Collins, Parsons, and Mayou pronounced the case as belonging to the type of "retinitis with massive exudation" described by Coats.

Coats† grouped together several cases of retinal exudation sometimes associated with vascular changes occurring in young people whose general health is usually perfect. This author regards the essential pathologic change to be hemorrhages in the outer layers of the retina which frequently break through externally, disintegrate, and slowly organize into cicatricial tissue. The cause for the hemorrhages is not understood; the choroid does not play an important part in the process.

Leber‡ believes that these changes do not follow hemorrhages, but are a deep-seated inflammatory and necrosing process, often associated with hemorrhages, and that there are cases with pronounced choroidal changes. Leber does not

*Trans. Ophth. Soc. U. K., 1916, p. 345.

†Royal London Ophth. Hosp. Rep., 1908, xvii, p. 440.

‡Retinitis exudativa, Graefe-Saemisch-Hess, vii, 2.

accept Coats' view that the fibrin is derived from hemorrhage, because he has frequently observed an extensive fibrinous exudation without any blood-corpuscles being present.

Friedenwald,* in an article on Retinitis with Massive Exudation, described the case of a young man, aged eighteen, who showed an extensive retinitis presenting a uniformly white, partly mottled surface, with peripheric hemorrhages, and two prominent masses which resembled choroidal sarcoma; the blood-vessels were markedly diseased and there were vitreous opacities. The eye subsequently was enucleated, and Verhoeff,† on microscopic examination, found large, well-defined areas of hyaline degeneration, apparently following proliferating processes with deposits of lime and cholesterin crystals.

The case which I have just reported differs from those described by Coats in that Coats' retinitis occurs in young persons and is generally accompanied with curious vascular changes. Of particular interest are the ophthalmoscopic changes observed in the other eye of this patient; these were chorioretinitis in the macular region, with deep hemorrhages and pigmentation, connective-tissue formation in the retina, and sclerosis of the choroidal vessels.

Through the courtesy of Dr. H. M. Smith, of Brooklyn, I have recently observed a similar case in a man sixty-nine years of age. In the macular region there was a sharply defined, bluish-gray mass with some mottling and 4 D. of swelling. At the upper part there was a large, deeply placed retinal hemorrhage. The retinal vessels showed arteriosclerotic changes, and in the periphery some of the vessels were obliterated and there were newly formed connective-tissue changes. The retina covering the mass showed delicate wrinkling, like crackled parchment, a condition which suggests a shrinking of the underlying exudate.

It seems to me that these two cases represent a lesion in

*Trans. Amer. Ophth. Soc., 1914, p. 819.
†Trans. Amer. Ophth. Soc., 1909, p. 283.

the eye-ground which belongs to arteriosclerosis. This is characterized by its occurrence in the macular region in patients of advanced years. The ophthalmoscopic picture is that of a subretinal mass, sharply outlined, of moderate elevation, 3 D., bluish gray in color, with some mottling, accompanied by other arteriosclerotic changes in the same or in the other eye.

This condition is of importance in the differential diagnosis of sarcoma of the choroid. It also somewhat resembles the conglomerate tubercle; the latter condition, however, occurs at an earlier age, the color of the tumor is more yellowish-white, the elevation is greater, and the tuberculin test may show some local changes.

DISCUSSION.

DR. F. H. VERHOEFF, Boston: I recently examined an eye from a similar case which had been removed by Dr. Wells, of Boston. I did not see the case clinically, but it corresponded to the description given by Dr. Knapp. I feel sure that this tissue results from senile hyperplasia of the pigment epithelium. While I have seen the pigment epithelium produce similar tissue in other parts of the retina, I do not recall having seen it in the macula before. I think that Dr. Knapp is undoubtedly correct in thinking that the condition is caused by arteriosclerosis, and the fact that there was senile central chorioretinitis in the other eye of his patient substantiates his view.

DR. EDWARD JACKSON, Denver: I recall a case in which, on the first examination, I made a diagnosis of probable sarcoma in a tumor of the choroid at the macula. The swelling, as I recollect, was $1\frac{1}{2}$ or 2 diopters, and pretty sharply limited at its margins. There was a history of central scotoma. Vision had been going down for several weeks. However, although there was a negative Wassermann, he was put on potassium iodid, and in the course of three or four weeks the edge of the tumor was distinctly less abrupt. This went on, and within four to six months all appearance of tumor in that region had disappeared.

ATYPICAL DISSEMINATED CHOROIDITIS DUE TO DISEASE OF THE ACCESSORY SINUSES.

JOHN E. WEEKS, M.D.,
New York.

The accredited causes of disseminated choroiditis are, as we all know, quite numerous. Principal among them are syphilis, inherited or acquired, tuberculosis, and any profound disturbance of the system, such as anemia and malaria. Fuchs remarks that "in many cases of disseminated choroiditis the causes are obscure." As the study of the causes of diseases of the eye advances we are becoming apprised of the fact that a larger and larger percentage of the cases of inflammation of the various tissues of the eye and its adnexa are caused by so-called focal infections, as from the teeth, tonsils, accessory sinuses, and other small foci in various parts of the body; also by so-called ptomains originating in the intestinal tract. The recognition of certain diseases of the eye admonish us that a number of examinations must be carefully and competently made, such as were not dreamed of some years ago, in order that a cause may be discovered and a cure made possible.

Case I.—Max F., aged twenty-six years, a post-office laborer, came under my observation February 17, 1908. Disturbance of the vision of the right eye began three years previously. The eye became hyperemic and painful, and vision was diminished. The left eye has been hyperemic from time to time, but vision has been good until recently. There is no history of syphilis or gonorrhea. Wassermann and Noguchi tests negative. Aside from the ordinary colds, there is no history of nasal disease.

Case 1.—Right eye.

Ocular conjunctiva of both eyes flushed. Tension normal. V.R.E., 9/200; L.E., 20/20, with correcting lenses. The fields of vision were contracted concentrically. The right field presented a relative central scotoma, almost absolute. Ophthalmoscopically a few small opacities of the vitreous body were observed in both eyes. Discs approximately normal. Above the disc and to the temporal side in the right eye was a circular patch of exudation slightly smaller than the disc. A narrow atrophic patch extended from this to the macula. There was also a small circular patch of exudation about two disc diameters below the disc. In the periphery of the fundus there were a number of small pale patches which seemed to be foci of exudation undergoing absorption. In the left eye there was a raised patch of exudation above and to the nasal side of the disc, about the size of the disc, and a few small patches in the periphery. The patient's general condition was fairly good. Blood negative. Urine negative. Examination of the nasal cavities and pharynx, made in a casual manner, did not disclose any marked pathologic changes. The tonsils were not large, and appeared to be in good condition. In the search for a cause, tuberculosis was suspected. A thorough test was made by means of the subcutaneous injection of tuberculin, with negative results. In spite of this a short course of therapeutic doses of tuberculin was carried out to see if the condition might not be of tubercular origin, in spite of the negative diagnostic tests. The salicylate of soda, bicarbonate of soda, mercury, and the iodids were given in moderate doses and long continued. The diet was regulated and measures taken to keep the nasal and pharyngeal mucous membranes in good condition.

The condition of the fundus of each eye improved slowly, vision remaining the same. There would be occasional spells of hyperemia of the conjunctiva of one or both eyes, which would subside in a few days. The patient disappeared from observation May 10, 1909, and was not seen again until June 28, 1917. At this time the patient was suffering from an acute attack of glaucoma in the left eye. Vision, 14/200. Tension, 56. The patient was admitted to the New York Eye and Ear Infirmary. The attack subsided under miotics and free catharsis. The tension returned to the normal and the

vision to 20/30. At the end of two weeks the patient left the infirmary, but the moderate use of miotics was continued. An *x*-ray examination of the lateral sinuses was now made by Dr. Dixon, and all of the sinuses, except the right antrum, were found to be cloudy. The patient was referred to a rhinologist for correction of the condition of the sinuses, and operation was proposed but declined, palliative measures being preferred.

The glaucomatous condition in the left eye fluctuated considerably, but the visual fields remained unaltered up to May 20, 1918, when another quite severe attack of glaucoma was experienced, the right eye remaining unaffected. A Lagrange operation was now performed, and as soon as this was sufficiently recovered from, operation for the correction of the condition of the accessory sinuses was insisted upon. Radical operation, divided into two procedures, was performed by Dr. T. L. Saunders, of New York. The left antrum and the ethmoid and sphenoid cells were found to be diseased. Immediate improvement in the condition of the eyes and of the patient's general health followed the operation, and, apparently as the result of the free drainage of the accessory sinuses, the eyes became clear and vision in the left eye became 20/20−. Since the operation on the sinuses there has been a recurrence of blocking of posterior ethmoids and sphenoids, and it has been necessary to remove granulations and to enlarge the openings to admit of free drainage. On each occasion of blocking the eyes have become flushed and painful, and some falling off in the vision of the left eye has occurred, these symptoms subsiding when the drainage again becomes good. At present the vision of the right eye is 10/200; of the left eye, 20/30−. The fields of vision are as when first measured. There are some small opacities in the vitreous of both eyes.

CASE II.—Frank F., aged twenty-nine years, was first seen by me July 21, 1915. There was a history of impaired vision dating back some years. An operation had been performed on the nasal septum. The patient has suffered two attacks of facial erysipelas. Dr. H. W. Wootton, who had previously observed the patient, reported that there was no syphilis. Tension and motility normal. Fields normal in

Case 2.—Right eye.

extent. V.R.E., 20 200; L.E., 20 30—. Optic discs normal, except in their temporal thirds, which are slightly pale. Scattered throughout the periphery of the fundi are small, irregular, circular, pale spots, some of which are atrophic with pigmented borders. Some present hazy borders, indicating the presence of more or less exudate. The patient was put on the iodids and mercury and the salicylate of soda in small dose, which was continued for some time. Diet regulated. Nasal and pharyngeal mucous membranes treated with cleansing sprays. April 18, 1916, V.R.E., 20 200; L.E., 20 30—. Tension right eye normal; left eye, slightly plus. Tonsils apparently normal.

I did not see the patient again until January 9, 1919, when vision was L.E., 20 30—. The fundi then presented the appearance of disseminated choroiditis. The patient was having trouble with his nose and ears.

An examination of the accessory sinuses by *x*-ray was made and the ethmoid and sphenoid sinuses showed cloudiness. Wassermann tests were made of blood and spinal fluid and were negative. *X*-ray of teeth negative. Tests for tuberculin negative. June 16, 1918, accessory sinuses operated on by Dr. A. Trask Hutchinson, who reports as follows: "I performed a double ethmoid operation and opened both sphenoids, removing many polypi. Patient developed inflammatory rheumatism shortly afterward, with an exacerbation of chronic Bright's disease." The patient gradually recovered, and on April 19th was in good physical condition. V.R.E., 20 200; L.E., 20 20. The fundus at present appears as shown in the drawing.

Although positive proof of disease of the accessory sinuses as the cause of the choroidal condition may not be acceded, in the absence of syphilis, tuberculosis, and other apparent infectious foci, it appears to the writer that the long-continued infectious condition of the accessory sinuses may well be regarded as the cause. At any rate it is sufficiently suggestive to make it evident that it is desirable to carefully examine the accessory sinuses in all cases of choroidal exudative processes, particularly when syphilis and tuberculosis have been excluded.

VISUAL ACUITY AT LOW ILLUMINATION—APPARATUS AND RESULTS.

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(By invitation)

INTRODUCTION.—The incentive to this work was a request by the naval authorities* for an apparatus suitable for a quick and accurate test of acuity at low illuminations. Experience of the trial and error sort has shown, roughly speaking, that only 20 to 25 per cent. of the men on the battleships have a sufficiently keen acuity at low illumination to qualify for all branches of the lookout and signal service work. An apparatus has been devised by means of which a wide range of illuminations, beginning at 0.07 meter-candle or lower, may be covered in just noticeably different steps, with no change in the color value of the light and with a specification at each point of the intensity of light falling on the test-object. The apparatus will be described here, and results will be given later in the paper covering the following points: (1) The range of minimum illumination required by a number of normal eyes for the discrimination of certain standard test-objects. (2) Individual variations in the amount and rate of adaptation to low illumination in terms of the effect on acuity. And (3) the sensitivity of the acuity test, when applied at the minimum illumination at which the test-object can just be discriminated for the detection of small errors in refraction and in their correction.

* This request came to us through Commander G. B. Trible, of the U. S. Naval Hospital at Washington, to whom we are indebted for the suggestion of the problem. The apparatus is now in use at the Naval Hospital.

THE APPARATUS.—Among the requirements for an apparatus for determining acuity at low illuminations or the effect of change of illumination, the following points may be mentioned: (1) A means of changing the illumination by small amounts over a wide range, beginning at or below the threshold for the test-object employed, without changing the color value of the light. If, in making this change, the color value of the light is altered, it is obvious that another factor affecting the results is introduced. (2) A means of keeping constant for an indefinite length of time any desired intensity of illumination and of reproducing this intensity at will. Also the test-object must be uniformly illuminated. (3) A means of specifying accurately at any point in the scale the intensity of light falling on the test-object. And (4) it is desirable that the apparatus employed for controlling the illumination can be used with the test-objects already accepted in clinic practice.

The most difficult problem one has to face in constructing an apparatus for determining the minimum amount of light that permits of the discrimination of a given test-object, more particularly if that object consists of a line of test-letters, is to secure a uniform illumination of the line. This problem is relatively unimportant at the illuminations ordinarily used in acuity testing, because at these illuminations acuity changes so slowly with change of intensity of light that the differences which may occur throughout the line of test-letters do not ordinarily produce a detectable effect on the results of the test. However, if no more care is exercised at the threshold to secure uniformity of illumination than is ordinarily used at the higher illuminations, no single intensity at the source will serve for the discrimination of all the letters of the line. We were able satisfactorily to meet this difficulty in only one way, namely, by selecting an aperture sufficiently small to permit of its uniform illumination and projecting the magnified image of this aperture on

the test-card. That is, an aperture was selected of such a size and shape that when magnified fivefold, it gave a band of light which just blocked off one line of the test-letters. It is obvious that this aperture could be made of different sizes and shapes, depending upon what is wanted in the projected image. For example, two or three lines of test-letters could be blocked off if desired, or the whole card or any part of it could be illuminated. There is no reason, moreover, why the aperture could not be made adjustable in size to suit the needs and preference of the individual operator. The changes in intensity of light were produced by means of an iris diaphragm. When such a diaphragm is placed either at the front or back surface of the focusing lens, changes in the flux of light can be produced without any alteration in the size or shape of the image produced by the lens, just as happens, for example, in the action of the iris of the eye.

A photograph of the apparatus is shown in Fig. 1. At A is represented the lantern or lamp house, which is, of course, the important feature of the apparatus. It contains the source of light, the aperture, the diffusing surfaces, the focusing lens, and the iris diaphragm. The source of light is a well seasoned type C Mazda lamp of the round-bulb stereopticon type of 100, 250, or 500 watts, depending on the range of illumination that is desired. This lamp is installed vertically in the roof of the lamp house at such a height that its filament is well above the aperture which is to be illuminated. In order to secure a uniform and diffuse illumination of the aperture the lamp house is lined with opal glass ground on one side. The aperture, 6 x 1 cm., is cut at the center of the cap, covering the inner end of the projection tube B. Further, to aid in the even illumination of the aperture it is covered with a diffusing slide of ground glass. At the further end of the projection tube, 18.1 cm. from the aperture, in a brass ring and collar, is mounted the

focusing lens. This lens is 7.5 cm. in diameter, and has a focal length of 15 cm. It is scarcely needful to point out here that a different strength of lens could have been used and different relative distances of aperture and test-card from the lens. With appropriate variations in these factors the distance of the lantern from the test-card and the amount of magnification of the projected image may be varied. Any

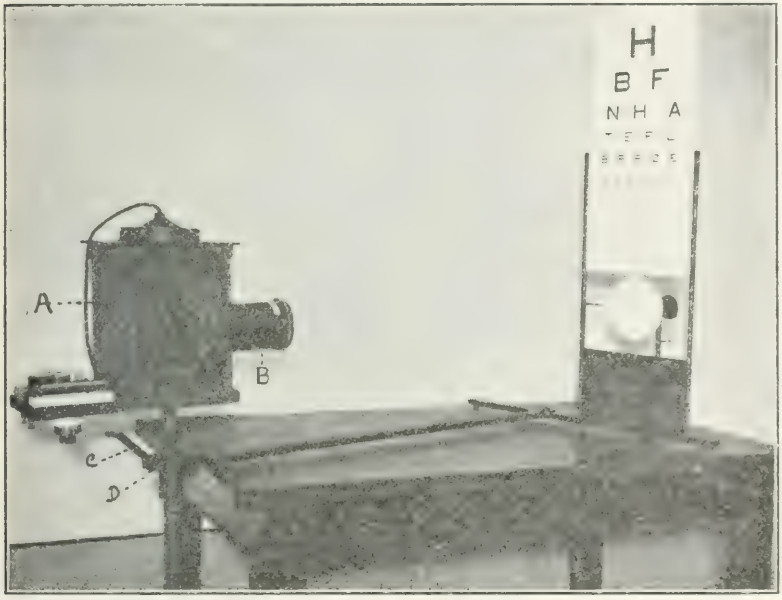

Fig. 1.—Acuity Lantern and Apparatus for Determining Acuity at Low Illuminations.

increase of magnification results, of course, in a decrease in the brightness of the image; hence an increase in the scale of brightness of image with no change in its size could have been obtained by increasing the size of the aperture and by decreasing correspondingly the amount of magnification. In the construction of the present apparatus a 15 cm. focal length lens was used because it could be obtained the most

readily on the market of the diameter needed. Just back of the lens, mounted in the same ring, is the iris diaphragm. The pupillary diameter of this diaphragm ranges from 5 to 65 mm. At a suitable point on the circumference of the diaphragm is fastened a pointer which, as the diaphragm is opened and closed, moves over a translucent millimeter scale. This scale is mounted over a slot in the projection tube and receives its illumination from the light inside of the tube. The inside of the tube is painted a mat black. To prevent the overheating of the lamp house a rather elaborate ventilating system is provided, consisting of a light-tight ventilating hood at the top and a series of holes on two sides at the bottom of the housing, furnished with light-tight shields. On the platform supporting the lamp house are mounted a small Weston ammeter and a small rheostat to guard against fluctuations in the current and consequent fluctuations in light intensity. In order that any line on the chart may be illuminated at will the platform supporting the lamp house is mounted at the end of a rod which is raised and lowered by means of a rack and pinion. The pinion is operated by the small crank C, and the position of the housing is fixed at any given height by means of the set-screw D. The test-card is mounted in a frame at a distance of 81.6 cm. from the focusing lens.

In order that the intensity of light used at any time may be known, a calibration chart is provided in which are given the readings on the millimeter scale and the equivalent meter-candle values at the test-card. This calibration was accomplished as follows: The lamp house was removed and mounted on a photometer bar at a distance from the photometer head equal to its original distance from the test-card. The scale was then gone over point by point, and the meter-candle value of the light at the photometer head was measured. The calibration table is shown in Fig. 2 A. In Fig. 2 B is shown the calibration curve in which the divisions of

the millimeter scale are plotted against meter-candles at the test-card.

For our own use in the laboratory we have preferred to substitute for the Snellen chart a single test character which can be turned in different directions, and the judgment of its direction rather than the recognition of the character be required of the observer as a test of discrimination. Our reasons for this preference are as follows: (1) A test-letter

CALIBRATION TABLE.

DIAPHRAGM SETTING	METER-CANDLES	DIAPHRAGM SETTING	METER-CANDLES
82.5	9.19	46.0	2.46
82.0	9.04	44.0	2.23
80.0	8.54	42.0	2.02
78.0	8.06	40.0	1.81
76.0	7.58	38.0	1.61
74.0	7.12	36.0	1.43
72.0	6.67	34.0	1.27
70.0	6.23	32.0	1.12
68.0	5.81	30.0	0.97
66.0	5.43	28.0	0.82
64.0	5.06	26.0	0.69
62.0	4.71	24.0	0.58
60.0	4.36	22.0	0.48
58.0	4.02	20.0	0.38
56.0	3.72	18.0	0.28
54.0	3.45	16.0	0.21
52.0	3.18	14.0	0.16
50.0	2.93	12.0	0.11
48.0	2.69	10.0	0.07

Fig. 2A.

may be recognized when it is not seen at all clearly. Recognition is too dependent on extra-ocular functions to be used with precision as a measure of ocular capacity. (2) The different test-letters of the Snellen chart set an unequal task for the resolving power of the eye. (3) By the use of the same test character, turned in different directions at will, all possibility of learning the test series is eliminated. Also the test-object becomes much more valuable for the detection of astigmatisms. And (4) at low illumination the eye fatigues

very rapidly. Thus if the task is the reading of the whole line of letters, the results obtained measure not only acuity,

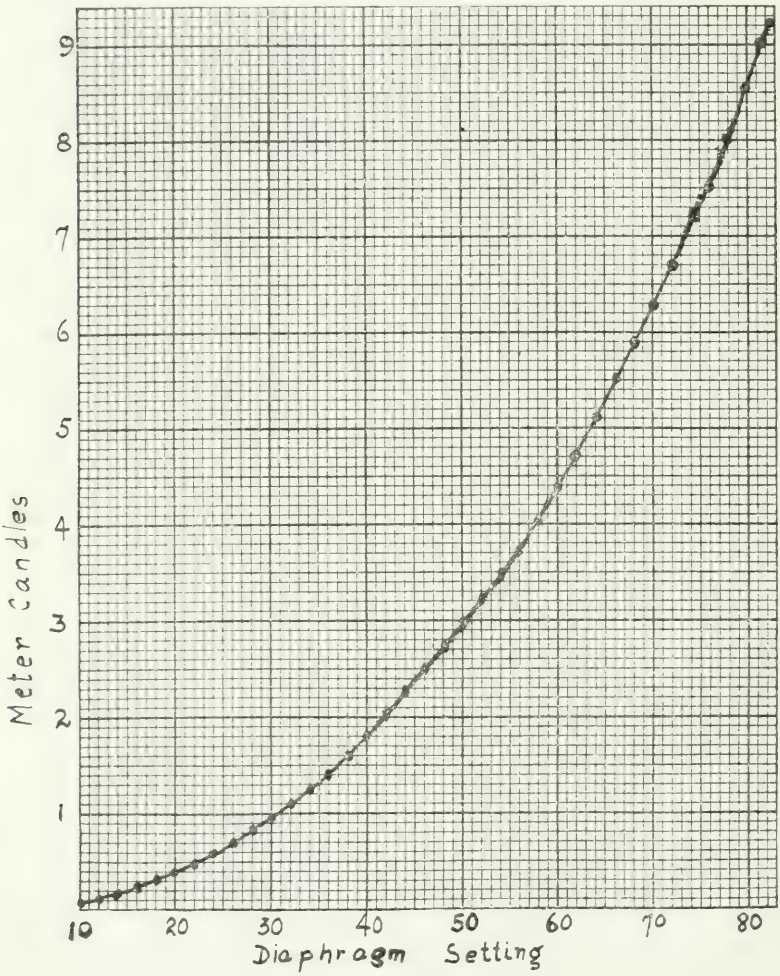

Fig. 2 B.—Calibration Curve.

but the power to sustain acuity, which may or may not be compatible with the purpose of the test.

As stated in the introduction, the apparatus was designed to meet a specific testing need of the navy. However, it has, we believe, the following uses in clinic work. (1) When used with a higher watt lamp, it provides an acuity test apparatus or lantern by means of which the test-card can be illuminated by a constant and known intensity of light abundantly high in the scale to meet the Snellen standard of acuity. (2) When used with the 100-watt lamp, it serves for those cases in which there is need for the testing of scotopic or twilight vision in terms of the effect on acuity; also the amount and rate of scotopic adaptation. It thus affords a very feasible and precise means of testing the light sense in so far as it affects the power to see clearly—the effect with which we are the most concerned for the greater part of our working lives. Moreover the 100-watt lamp is sufficient for the testing of photopic acuity in case of the greater number of eyes which would ordinarily be graded as normal. (3) If the image of the aperture is projected on a blank white surface of good reflecting power, more particularly if its size and shape are changed to that of a square or circle of dimensions favorable for making a sensitive judgment, the apparatus can be used with an equal degree of precision and convenience for testing the light sense directly in terms of the amount of light required to arouse just noticeable sensation. That is, the threshold of sensation can be determined in terms of meter-candles of light falling on the test surface. And (4) by making it possible to determine with great exactness the minimum illumination at which the test-object can just be discriminated, the apparatus provides a very sensitive means for detecting small errors in refraction and in their correction, as will be demonstrated later in the paper.

Sensitivity for detecting small errors in refraction and in their correction could also be added to the acuity test by using a test-object, small changes in the size of which could be made. However, no means has as yet been provided for

making small changes in the size of any acuity object sufficiently complicated in form to test simultaneously the resolving power of the eye in any great number of meridians, which is, we believe, a very important feature in determining the exact location of an astigmatism or the exact amount and placement of its correction.

We consider this an important feature in testing for astigmatism because of our belief that the astigmatic eye, in the attempt to compensate for its defect, has, in many cases at least, acquired unusual powers and habits of accommodation. Our belief in this is based on three sets of observations: (1) In the use of the astigmatic chart without a cycloplegic in cases of low astigmatism, one is frequently annoyed by the astigmatic indication shifting from one meridian to another. (2) We have found observers who could voluntarily, in some cases requiring considerable practice, shift the meridian showing the astigmatic indication. And (3) in our test of astigmatism, based on the relative speed of discrimination in the different meridians, presented to this Society last year, the speed of discrimination for the least favorable meridian can be increased by practice almost to equal that in the most favorable meridian with an equal amount of practice. This result is so noticeable that, in order to make the test sensitive, we were compelled to eliminate as much as possible the opportunity for the practice effect. This was done in two ways: (1) The series was always begun below rather than above the minimum time of exposure required just to detect the direction in which the test-object was turned. And (2) meridians were inserted in the series clearly outside of the region of maximum astigmatic effect in order to break up any progressive tendency to accommodate, especially for the meridian showing the poorer resolving power. The fact that the eye can with long exposures discriminate a fineness of detail in its unfavorable meridian, which it is utterly unable to master with short exposures, and that this excess

lag may be overcome in a considerable measure by practice, seems to indicate that it has the power, through its act of accommodation, to overcome in part the effect of meridional inequalities in resolving power, at least when a test-object taxing the resolving power in only one meridian is turned successively in different meridians. In any event it seems only the part of sound procedure to guard against the possibility of selective meridional accommodation by the use of a test-object which taxes the resolving power of the eye simultaneously in as many meridians as possible.

But even if a test-object complicated in form and minutely adjustable in size were available, a device for determining the minimum illumination at which a test-object subtending the standard visual angle can just be discriminated would afford a still more sensitive means for the detection of low astigmatisms and small errors in the amount and placement of their correction. This follows rather obviously from the fact that acuity changes slowly with change of illumination. That is, small differences in acuity correspond, comparatively speaking, to large differences in illumination, more particularly in the middle and upper parts of the intensity scale. Used as we have recommended, the illumination scale thus becomes in effect an amplified indicating scale by means of which the relatively slight differences in acuity, represented by the proper correction of an error in refraction, and small deviations therefrom, may be detected with comparative ease and certainty. It is not infrequent perhaps to find that, in cases of low astigmatism, with the full illumination of a test-object presenting no smaller gradations in visual angle than are found in the Snellen chart, the observer is able to detect no difference in the ease or clearness of discrimination of the test character through a range of 20 to 40 degrees in the placement of the correction. This difficulty is especially annoying in the case of children and the unintelligent, untrained, and subjective types of adult. In such cases the

apparatus shown here is especially helpful. With it a minimum is left to the comparative and observational powers of the subject. All that he is required to do is to indicate the direction in which the test-object points, the most favorable amount and placement of the correction being determined by the minimum amount of illumination at which he is able correctly to give this indication. The apparatus possesses ample sensitivity, as our results will show, for the detection of an error of 5 degrees in the placement of the correction of a low astigmatism, or of 0.12 diopter in the amount of the correction.

It will be noted, for example, in the tables given later in the paper, that an error of 5 degrees in the placement of the correction of an astigmatism produced by a 0.25 diopter cylinder required, as an average for five eyes, 66.5 per cent. more light for the discrimination of the test-object than the correct placement; in case of an astigmatism produced by a 0.75 diopter cylinder, it required 107.5 per cent. more light than the correct placement. The large number of scale divisions between the settings of the light control for the correct and the incorrect placements of the cylinder will be noted also in these results. In case of the 5-degree displacement of the correction of the 0.25 diopter astigmatism this difference averaged 9.5 for the five eyes. That is, since the apparatus can be readily set to half divisions, 19 settings of the light control could have been made with precision between the values needed for the true correction and the 5-degree displacement. This shows that the sensitivity of the apparatus far exceeds the present possibilities of the precise manipulation of the correcting cylinders.

In case of an error of 0.12 diopter in the amount of the correction, 54.9 per cent. more light was required for the least favorable than for the most favorable meridian; and in case of an error of 0.25 diopter, 106.7 per cent.

THE RANGE OF ILLUMINATION REQUIRED BY NORMAL EYES FOR THE DISCRIMINATION OF THE STANDARD TEST-OBJECT.

In making these determinations three test-objects were used: the Snellen chart and two single test-objects which could be rotated into different positions, the letter E and the broken circle, each subtending a five-minute angle. The determinations were made at the beginning and end of a forty-five-minute adaptation period. It is obvious, from the preceding discussion, that the results at low illumination would be influenced by the refracting condition of the eye as well as by its power of scotopic vision. In order to make the results represent as far as possible the difference between scotopic and photopic vision, each eye was refracted and the acuity was taken under five foot-candles (53.8 meter-candles) of light. In the first series of tests 22 observers were used, ranging from eighteen to twenty-eight years of age. Results were obtained for both eyes and for the two eyes separately. Of the eyes used, 75.7 per cent. were able to read at six meters the test-type designed to be read at four meters; 13.5 per cent., at six meters the test-type designed to be read at five meters; and 10.8 per cent., at six meters the test-type designed to be read at six meters. It was our intention, throughout the work, to use only eyes that could be ranked as grade A with regard to photopic acuity.

The results of these determinations show a greater range of individual difference for the broken circle than for the Snellen chart or the letter E (1233 per cent. for the broken circle, 548 per cent. for the letter E, and 357 per cent. for the Snellen chart). This superior showing for the broken circle is perhaps in accord with the general finding that the broken circle as a test-object picks up smaller differences in acuity than either of the other two test-objects employed. These differences, too, it will be remembered, are amplified

in the present case by the fact that they are read on the illumination scale and not on a scale which sustains a 1 to 1 relation with acuity. Inasmuch as the greater sensitivity was shown in these preliminary experiments by the broken circle as test-object, 15 additional observers were employed using this test-object alone.

Space will be taken here only for a brief general statement of the results for this latter series of determinations. (1) The individual differences in the minimum illumination required for the discrimination of the test-object before the period of dark adaptation fell between 0.55 and 5.29 meter-candles, a range of 862 per cent.; after the forty-five-minute period of dark adaptation, between 0.32 and 2.2 meter-candles, a range of 593 per cent. A greater range of individual difference, it will be noted, was found for the tests taken before the period of dark adaptation than for those taken after the forty-five-minute adaptation period. This was doubtless in part due to the lack of careful standardization of the initial sensitivity by a period of preadaptation to light of a fixed intensity, and in part to individual differences in the amount and rate of adaptation. A careful initial standardization of sensitivity was purposely avoided in this preliminary work with the apparatus in order more closely to approximate the rough conditions of testing which are apt to prevail in the selection of men with reference to vocational fitness.

(2) Thus far, without exception, the two eyes of the same observer have required a different amount of light just to discriminate the test-object. The minimum difference in this regard for the 15 observers employed, after the forty-five-minute adaptation period, was 0.12 meter-candle, 19 per cent. of the amount required for the better eye; the maximum difference was 1.50 meter-candles, 53.6 per cent. of the amount required for the better eye.

(3) A question is often raised with reference to points of

advantage of binocular as compared with monocular seeing. In 6 per cent. of the number of cases tested the binocular result was equal to or approximated the result for the poorer eye; in 88 per cent. of the cases it was better than the results of either eye; and in the remaining 6 per cent. of the cases it was intermediate to the results obtained with the two eyes separately. In none of the cases tested was it equal or approximately equal to the result for the better eye. In the 88 per cent. of cases referred to less light was required for the discrimination of the test-object by the two

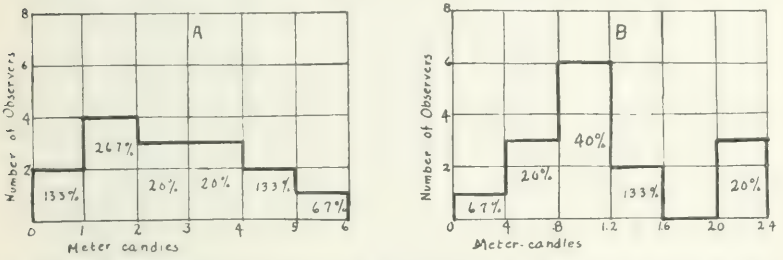

Fig. 3.—Representing the relative distribution of 15 observers graded with reference to the minimum illumination required just to discriminate the test-object: A, Before adaptation; B, after a forty-five-minute period of dark adaptation.

eyes than by the better eye alone by amounts ranging from 14.5 to 67.3 per cent.

In order to get a rough idea of the grouping of the 15 observers with reference to the minimum amount of light required to meet the standard of acuity imposed by the test, before and after the period of dark adaptation, they have in each case been divided into six equally spaced groups, each group for the work before adaptation covering a range of 1 meter-candle and for the work after adaptation a range of 0.4 meter-candle. For the tests before adaptation 13.3 per cent. fall in the first or best group; 26.7 per cent. in the second group; 20 per cent. in the third group; 20 per cent. in the fourth group; 13.3 per cent. in the fifth

group; and 6.7 per cent. in the sixth group. For the tests after adaptation 6.7 per cent. fall in the first group; 20 per cent. in the second group; 40 per cent. in the third group; 13.3 per cent. in the fourth group; none in the fifth group; and 20 per cent. in the sixth group. A graphic representation of this grouping is shown in Fig. 3.

Individual Variations in the Amount and Rate of Adaptation in Terms of Effect on Acuity.

The preceding experiments furnish data with regard to the minimum amounts of light required just to discriminate the different test-objects at the beginning and end of the forty-five-minute adaptation period. In case of the 15 observers tested with the broken circle in the final series of experiments at the beginning of dark adaptation and at the end of fifteen, thirty, and forty-five minutes, the minimum difference in this amount of light was 0.18 meter-candle or 22 per cent. of the amount required at the end of the adaptation period; the maximum was 3.44 meter-candles, or 452.6 per cent. required at the end of the adaptation period. These results are shown in Table I.

In addition to these experiments a special adaptation series was run in which the minimum illumination required just to discriminate the test-object was determined at the beginning of the adaptation period, and at the end of five, ten, fifteen, twenty-five, thirty-five, and forty-five minutes. In order to standardize the initial sensitivity of the eyes of the observer, a preadaptation period of twenty minutes was given to 80 foot-candles of light (vertical component), the skylight illumination of an optics room on a medium bright day. A few of the results obtained are represented in Table II and in Figs. 4 and 5. These results, it will be remembered, represent adaptation only as it affects acuity, which is the effect of greatest importance to the special work for which the apparatus was devised and the effect with which we are

TABLE I.

SHOWING THE AMOUNT OF LIGHT REQUIRED JUST TO DISCRIMINATE THE TEST-OBJECT AT THE BEGINNING OF DARK ADAPTATION AND AT THE END OF FIFTEEN, THIRTY, AND FORTY-FIVE MINUTES (FIFTEEN OBSERVERS). IN THESE EXPERIMENTS THERE WAS NO STANDARDIZATION OF THE INITIAL SENSITIVITY BY A PREVIOUS ADAPTATION TO AN ILLUMINATION OF CONSTANT INTENSITY.

OBSERVER	PHOTOPIC ACUITY	ILLUMINATION IN METER-CANDLES REQUIRED JUST TO DISCRIMINATE THE TEST-OBJECT				DIFFERENCE IN ILLUMINATION REQUIRED AT BEGINNING AND AT END OF FORTY-FIVE MINUTES	
		Beginning	At End of Fifteen Minutes	At End of Thirty Minutes	At End of Forty-five Minutes	Meter-candles	Per Cent.
G	6/4	0.70	0.55	0.35	0.32	0.38	118.8
M	6/4	1.00	1.00	0.82	0.82	0.18	21.9
Mc	6/4	1.24	1.00	1.00	1.00	0.24	24.0
R	6/4	1.36	0.60	0.50	0.60	0.76	126.7
L	6/4	1.55	1.00	0.88	0.88	0.67	76.1
S	6/4	1.75	1.42	0.88	0.88	0.87	98.9
Th	6/4	2.11	0.82	0.94	0.94	1.17	124.5
Y	6/4	2.11	1.55	1.49	1.42	0.69	48.6
St	6/4	2.40	0.60	0.60	0.60	1.80	300.0
Sw	6/4	3.43	2.17	2.20	2.20	1.23	55.9
K	6/4	3.90	2.81	2.40	2.10	1.80	85.7
T	6/4	3.97	1.18	0.82	0.88	3.09	351.1
Sm	6/4	4.10	3.80	1.40	1.30	2.80	215.4
W	6/6	4.20	1.40	0.76	0.76	3.44	452.6
Ba	6/4	5.29	2.11	2.02	2.11	3.18	150.7

TABLE II.

SHOWING THE AMOUNT OF LIGHT REQUIRED JUST TO DISCRIMINATE THE TEST-OBJECT AT THE BEGINNING OF DARK ADAPTATION AND AT THE END OF FIVE, TEN, FIFTEEN, TWENTY-FIVE, THIRTY-FIVE, AND FORTY-FIVE MINUTES (SIX OBSERVERS). IN THESE EXPERIMENTS THE INITIAL SENSITIVITY WAS STANDARDIZED BY TWENTY MINUTES' PRE-ADAPTATION TO 80 FOOT-CANDLES OF LIGHT (VERTICAL COMPONENT), THE ILLUMINATION OF A SKYLIGHT OPTICS ROOM ON A MEDIUM BRIGHT DAY.

OBSERVER	PHOTOPIC ACUITY	ILLUMINATION IN METER-CANDLES REQUIRED JUST TO DISCRIMINATE THE TEST-OBJECT							DIFFERENCE IN ILLUMINATION REQUIRED AT BEGINNING AND AT END OF FORTY-FIVE MINUTES	
		Beginning	At end of Five Minutes	At end of Ten Minutes	At end of Fifteen Minutes	At end of Twenty-five Minutes	At end of Thirty-five Minutes	At end of Forty-five Minutes	Meter-candles	Per Cent.
I.....	6/4	0.55	0.505	0.42	0.35	0.32	0.35	0.35	0.20	27.1
II.....	6/4	0.705	0.42	0.42	0.32	0.32	0.32	0.38	0.325	85.5
III	6/4	1.06	0.76	0.60	0.46	0.35	0.46	0.46	0.60	130.4
IV.....	6/4	1.12	0.82	0.52	0.32	0.32	0.38	0.38	0.74	194.7
V.....	6/4	1.62	1.12	0.94	0.55	0.60	0.60	0.55	1.07	194.5
VI.....	6/4	2.20	1.12	1.14	1.18	1.36	1.24	1.24	0.96	77.4

the most concerned for the greater part of our working lives. A comparison of these results with those of similar series in which the object is to measure the increase in light sensitivity as a result of dark adaptation shows that just as

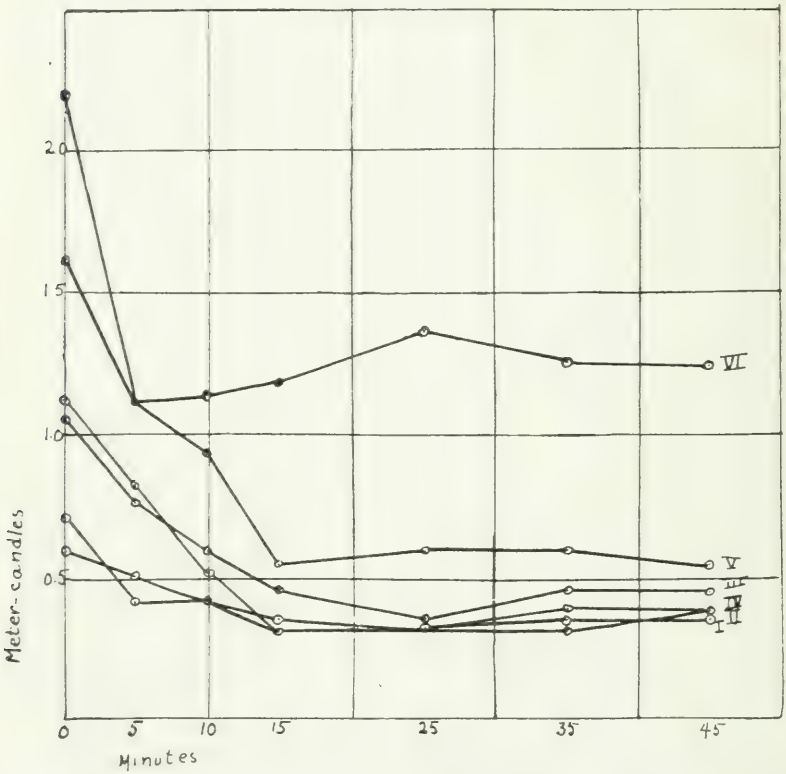

Fig. 4.—Curves showing the decrease in the amount of light required just to discriminate the test-object as the result of dark adaptation. In order to standardize the initial sensitivity, the eye was pre-adapted in each case for twenty minutes to 80-foot candles of illumination, vertical component.

acuity increases slowly with increase of illumination, so also does it increase slowly with increase of sensitivity to light. That is, the eye does not gain in acuity by adaptation nearly so much as it gains in light sensitivity.

In Fig. 4 the actual amounts of illumination required just to discriminate the test-object are plotted against time of adaptation. It thus affords a comparison of the position

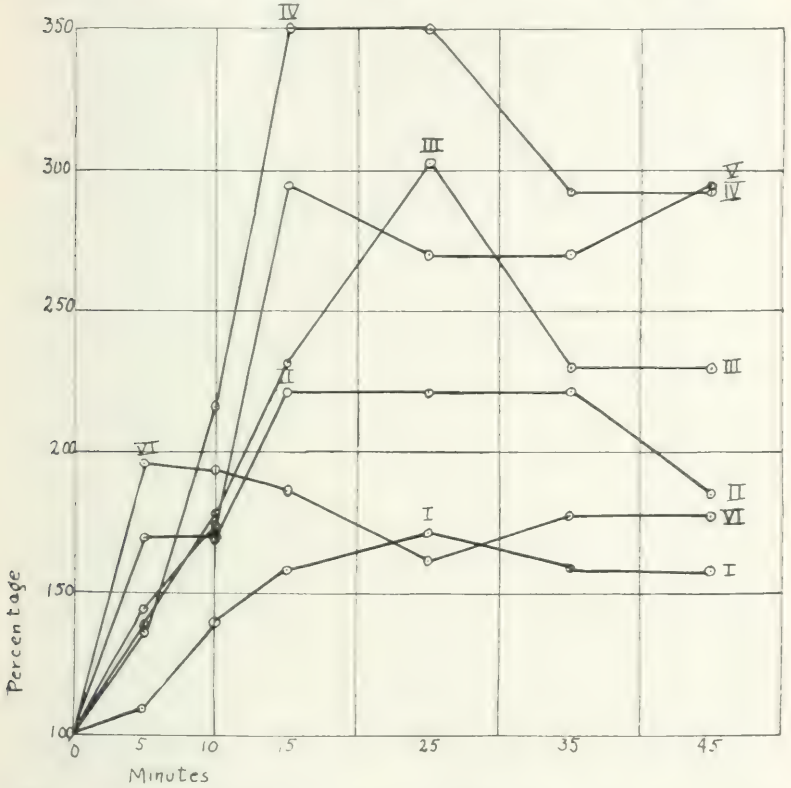

Fig. 5.—Curves showing the increase in sensitivity as the result of dark adaptation, the reciprocal of the amount of light required just to discriminate the test-object being taken as the measure of sensitivity. Percentage increase in sensitivity is plotted against time of adaptation. The initial sensitivity of the eye was standardized in each case by twenty minutes of pre-adaptation to 80-foot-candles of light, vertical component.

of the minima of the different observers in the illumination scale and comprehends data from which the following points may be determined: (*a*) Their relative ranking with regard to scotopic acuity before and after adaptation: (*b*) their

light sensitivity before and after adaptation measured in terms of the minimum amounts of light required just to discriminate the test-object; and (*c*) their relative amounts of change in sensitivity due to adaptation. All these features are important for vocational and clinical classification. In order to make these results more directly comparable with reference to the last of these points, namely, the relative amounts of change in sensitivity due to adaptation, they are plotted in Fig. 5 against the ratio or percentage increase in sensitivity, the reciprocals of the minimum amounts of light required just to discriminate the test-object being taken as the measure of sensitivity. That is, the ratio or percentage change in the value of these reciprocals is plotted against time of adaptation, the curves beginning at a common point or unit ratio. The relative rating with regard to the second point could, of course, be represented by plotting the reciprocals themselves. Space will not be taken here for this representation.

It will be noted that the greater part of these observers reach their maximum acuity at the end of fifteen minutes' adaptation, and that some even show a lower acuity if the series is continued beyond this time. The loss in the latter cases is doubtless due to fatigue of the muscles of adjustment. That is, in case of the observers more susceptible to muscle fatigue, the loss of acuity due to fatigue more than compensated for the small gain in light sensitivity after the first fifteen to twenty-five minutes. In this connection it may be noted that the strain imposed by taking the acuity at the minimum illumination is much greater than at the illuminations ordinarily used. Even with a five- to ten-minute rest period between determinations and a two-second interval between the individual observations making up one determination, a very noticeable fatigue was present at the end of the forty-five-minute series.

SENSITIVITY OF THE APPARATUS FOR DETECTING SMALL ERRORS IN REFRACTION AND IN THEIR CORRECTION.

There are doubtless many ways in which sensitivity may be added to the acuity test for the detection of small errors in refraction and in their correction. In connection with the problems which we have undertaken during the past eight years involving modifications and refinements in functional testing, three principles have come to light which may be used very effectively to this end. That is, the eye which suffers from an insufficient resolving power shows the following functional defects: (1) An undue lag or slowness in making the adjustments needed for clear seeing. (2) A marked loss in power to sustain the adjustments needed for clear seeing. And (3) an increase in the amount of light required just to discriminate details in the standard acuity object. The devising of test methods based on the first two of these principles has been treated of in former papers. The third alone will be considered here. For the purpose of demonstrating its sensitivity as a test principle, low astigmatisms and small errors in the amount and placement of astigmatic corrections have been chosen. Three cases will be considered: (1) Low astigmatisms produced by the use of weak cylinders. In this case the minimum amount of light required to discriminate the test-object in the most and least favorable meridians has been determined and at 5, 10, and 45 degrees from the most favorable meridian. (2) Small errors in the amount of the correction. And (3) small errors in the placement of the correction. In these latter cases also, in order to know just what the amount and placement of the correction should be, the astigmatism was produced by means of a cylinder of known strength and position, and the amount of illumination required just to discriminate the test-object with the true and the false correction was determined.

In choosing to use an artificial astigmatism in this work, it should not be understood that we believe that results with regard to the difference between the minimum amounts of light required for the true and the false correction would be obtained quantitatively identical with those which would be gotten with a natural astigmatism. We are too strongly impressed with the possibility that the astigmatic eye may progressively acquire power to compensate in part for its defect to be of this opinion. The artificial astigmatism was used solely that we might have an exact knowledge of the amount and location of the defect as a check on the determination made by the test. To have knowledge of a natural astigmatism adequate for this purpose would presuppose the supplementary use of a test of equal or greater precision than the one here proposed. We have not as yet been able to develop this precision with the tests already in use.

Sensitivity of Apparatus for Locating Meridian of Astigmatism.—It is obvious that if the eye has equal resolving power in all meridians, the amount of light required just to discriminate the test-object will be the same in all meridians; if the resolving power is not equal, the amount of light required will be different in the different meridians. In Table III it will be noted that in case of an astigmatism produced by a 0.25 diopter cylinder an average result for five eyes shows that 106.7 per cent. more light was required for the discrimination of the test-object in the worst than in the best meridian; at 5 degrees from the best meridian, 50.4 per cent. more light was required; at 10 degrees, 95.5 per cent.; and at 45 degrees, 106.7 per cent.

In case of an astigmatism produced by a 0.75 diopter cylinder, 178.3 per cent. more light was required in the worst than in the best meridian; at 5 degrees from the best meridian, 138.1 per cent.; at 10 degrees, 157.1 per cent., and at 45 degrees, 178.3 per cent.

Doubtless the apparatus can be used in different ways,

TABLE III.—SENSITIVITY OF APPARATUS FOR LOCATING MERIDIAN OF ASTIGMATISM. ASTIGMATISMS PRODUCED BY 0.25 AND 0.75 DIOPTER CYLINDERS.

Observer	Value of Cylinder Producing Astigmatism	Minimum Illumination Required for Discrimination of Test-Object (Meter-candles)					Difference in Result Between Best and Other Meridians							
							Meter-candles				Per Cent			
		Best Meridian	5° from Best Meridian	10° from Best Meridian	45° from Best Meridian	Worst Meridian	5°	10°	45°	Worst Meridian	5°	10°	45°	Worst Meridian
A	0.25	0.60	0.88	1.49	1.62	1.62	0.28	0.89	1.02	1.02	46.7	148.3	170.0	170.0
B	0.25	1.12	1.75	2.405	2.69	2.69	0.63	1.285	1.57	1.57	56.3	114.7	131.5	131.5
C	0.25	0.46	0.60	0.76	0.76	0.76	0.14	0.30	0.30	0.30	30.4	65.2	65.2	65.2
D	0.25	1.42	2.115	2.49	2.49	2.49	0.695	1.07	1.07	1.07	48.9	75.4	75.4	75.4
E	0.25	1.12	1.88	1.95	2.17	2.17	0.76	0.83	1.05	1.05	69.6	74.1	91.3	91.3
										Average	50.4	95.5	106.7	106.7
A	0.75	1.30	2.69	3.05	3.05	3.05	1.39	1.75	1.75	1.75	106.9	134.6	134.6	134.6
B	0.75	1.81	4.11	4.39	4.39	4.39	2.30	2.58	2.58	2.58	127.8	142.5	142.5	142.5
C	0.75	0.60	1.75	1.95	2.32	2.32	1.15	1.35	1.72	1.72	191.7	225.0	286.7	286.7
D	0.75	3.05	6.895	6.895	7.60	7.60	3.845	3.845	4.55	4.55	126.1	126.1	149.2	149.2
										Average	138.1	157.1	178.3	178.3

depending upon the experience and preference of the operator For example, the minimum amount of light required to discriminate the test-object could be determined for one meridian, and the setting of the light control be held constant, while the test-object is rotated into different meridians, the observer being required to judge in each case whether the same or more or less light would be required for its discrimination. This would serve as a rough indication of whether or not the eye is astigmatic. The exact meridian of the defect could then be worked down through a series of settings of the test-card and light control. A more feasible method, at least in the more apparent cases, doubtless would be first to determine the region of the defect by means of other tests, and use the present apparatus only for the more precise location of the meridian. A feasible method is also to use an astigmatic chart of the radial line or sunburst type, the lines of which are no more than five degrees apart. In this case the procedure would be to reduce the illumination until only one of the lines stands out clearly. This would give a precision, roughly speaking, of about five degrees. A more precise result could probably be obtained by featuring three or more of these lines on a rotating dial and turning the dial into the position which gave the sharpest difference between the single line and its neighboring lines.

Sensitivity of the Apparatus for Detecting Small Errors in the Placement of the Correction of an Astigmatism.—In Table IV it will be noted that in case of an astigmatism produced by a 0.25 diopter cylinder, a displacement of the correction 5 degrees from the true position required as an average result for the five eyes 66.5 per cent. more light than the true placement; and a displacement of 10 degrees, 93.3 per cent. more light than the true placement.

In case of an astigmatism produced by a 0.75 diopter cylinder, a displacement of 5 degrees required 107.4 per cent. more light than the true placement; and a displace-

ment of 10 degrees, 157.7 more light. The large number of scale divisions between the settings of the light control for the correct and incorrect placement of the cylinder will be noted also in this table. In case of the 5-degree displacement of the correction of the 0.25 diopter astigmatism, this difference averaged 9.5 for the five eyes. That is, since the apparatus can be readily set to half divisions, nineteen settings of the light control could have been made with precision between the values needed for the true correction and the five degree displacement. This shows that the sensitivity of the apparatus far exceeds the present possibilities of the precise manipulation of the correcting cylinders.

TABLE IV.—SENSITIVITY OF APPARATUS FOR DETECTING SMALL ERRORS IN THE PLACEMENT OF THE CORRECTION OF AN ASTIGMATISM.

Observer	Value of Cylinder Producing Astigmatism	Minimum Illumination Required for Discrimination of Test-object			Difference in Result for Correct and Incorrect Placements					
		Exact Placement of correction	5° Displacement	10° Displacement	Scale Divisions		Meter-candles		Per Cent.	
					5°	10°	5°	10°	5°	10°
A	0.25	0.60	1.33	1.62	13	17	0.73	1.02	121.7	170.0
B	0.25	1.12	2.25	2.69	17.5	22	1.13	1.47	100.9	131.5
C	0.25	0.46	0.60	0.65	3	4	0.14	0.19	30.4	41.3
D	0.25	1.42	1.55	1.88	2	7	0.13	0.46	9.2	32.4
E	0.25	1.12	1.94	2.17	12.5	20	0.79	1.05	70.5	91.3
				Average	9.6	14	0.58	0.84	66.5	93.3
A	0.75	1.30	2.49	3.05	17	22	1.19	1.75	91.5	34.6
B	0.75	1.81	3.43	4.39	17	22	1.62	2.58	89.5	142.5
C	0.75	0.60	1.42	2.12	14	24	0.82	1.52	136.7	253.3
D	0.75	3.05	6.44	6.44	20	20	3.39	3.39	111.1	111.1
				Average	17	22.5	1.75	2.31	107.5	157.7

Sensitivity of the Apparatus for Detecting Errors in the Amount of Correction of an Astigmatism.—It is obvious that if the astigmatism is fully corrected, the same amount of light will be required for the discrimination of the test-

object in all meridians; if not, an unequal amount will be required in the different meridians.

An average result for the five eyes shows (Table V) that in case of an error of 0.12 diopter in the correction, 54.9 per cent. more light was required in the worst than in the best meridian; in case of a 0.25 diopter error, 106.7 per cent. more light was required in the worst meridian; and in case of a 0.75 diopter error, 154.25 per cent. more light was required.

TABLE V.—SENSITIVITY OF APPARATUS FOR DETECTING ERRORS IN THE AMOUNT OF CORRECTION OF AN ASTIGMATISM.

Observer	Minimum Illumination Required for Discrimination of Test-object with Different Errors in Amount of Correction						Difference in Minimum Illumination Required to Discriminate Test-object in Most and Least Favorable Meridians					
	0.12 Diopter		0.25 Diopter		0.75 Diopter		0.12 Diopter		0.25 Diopter		0.75 Diopter	
	Best Meridian	Worst Meridian	Best Meridian	Worst Meridian	Best Meridian	Worst Meridian	Meter-candles	Per Cent.	Meter-candles	Per Cent.	Meter-candles	Per Cent
A	0.60	0.88	0.60	1.62	1.30	3.05	0.28	46.7	1.02	170.0	1.75	134.6
B	1.12	2.17	1.12	2.69	1.81	4.39	1.05	93.8	1.57	131.5	2.58	142.5
C	0.46	0.65	0.46	0.76	0.60	2.32	0.19	41.3	0.30	65.2	1.72	286.7
D	1.42	1.75	1.42	2.49	3.05	7.60	0.33	23.3	1.07	75.4	4.55	149.2
E	1.12	1.88	1.12	2.17	..	..	0.76	69.6	1.05	91.3	..	..
					Average		0.52	54.9	1.00	106.7	2.65	154.25

In addition to the points already noted, the above results in connection with those of the preceding experiments emphasize the especial need of good resolving power for all work at low illuminations. A small error in refraction or in the amount and placement of its correction is a much more serious handicap at low than at full illumination. A correction, for example, which is adequate for all practical purposes at full illumination, would in many cases raise the lower limit of clear vision to such a degree as seriously to disqualify the subject for work at low illuminations. It seems

fair to infer too from these results that the individual differences in the amount of light required as a comfortable working minimum, frequently encountered by the illumination specialist, are due to differences in resolving power as well as to differences in retinal capacity.

A STEREOMICROMETER—AN INSTRUMENT OF PRECISION FOR MEASURING STEREOPSIS.

Captain Harvey J. Howard, of the Medical Research Laboratory, Hazlehurst Field, Mineola, Long Island, N. Y., devised this instrument while working on the subject of judgment of distance (p. 195). It was suggested by one of his co-workers, Captain Percy W. Cobb, that the same form of test-objects in the hand stereoscopic instrument of precision be adopted for the purpose of producing any degree of depth illusion desired.

In the six-meter apparatus two black rods with a light surface background were viewed through the window of a box, the purpose being to learn the smallest depth-difference discernible by different individuals. The binocular parallax was found to be the essential factor in the resultant determinations. The respective depth judgment ability of individuals was reckoned according to their minimal binocular parallactic angles, which were computed from interpupillary distances and depth-difference thresholds.

In the hand stereoscopic instrument suggested there would be two pairs of vertical lines or objects to be fused. To produce a sense of depth the only other essential would be to effect a different lateral separation between the pairs of fused objects, *i. e.*, the binocular parallax would be applied directly and not indirectly, as is the case with the non-fused objects of the six-meter apparatus.

In addition to Captain Cobb, I am indebted to Mr. Max

Poser, of the Bausch and Lomb Optical Company, for valuable suggestions in formulating the final plans for the instrument.*

Description of the Instrument.—Fig. 1 represents a photograph of the completed instrument. Roughly, it is about nine inches high, six inches wide, and five inches deep. The hood and the box contain the four test-objects, which are small wires tightly drawn and enameled black. The pair of wires on each side in the completed instrument are 1.375 mm. apart, which gives them an angular separation from the center of the lens of exactly one centrad. This angle was decided upon because, in experiments with an apparatus at six meters and another at 100 meters, the centrad separation of the test-objects had always been used. From this standpoint, therefore, the results of all three forms of apparatus should be comparable. The lenses are as carefully made and adjusted as are those in a pair of field binoculars. Each lens has a focal length of 137.5 mm.

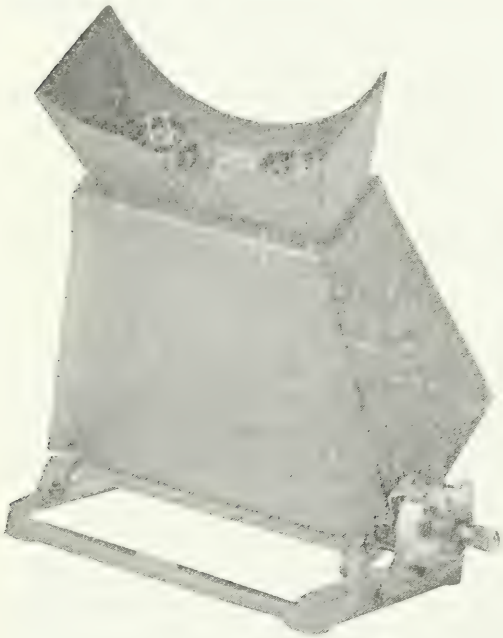

Fig. 1.—Stereomicrometer.

* Authority to make according to specifications granted February, 1919, to Bausch and Lomb Optical Company by the Supply Department, Hazlehurst Field, Mineola, Long Island, N. Y.

At the right side of the instrument is a micrometer screw which has a lateral movement of exactly 0.5 mm. for each revolution. Attached to the axis of the screw is a drum with its peripheral surface marked off into 100 equal parts. Each division on this scale represents a lateral shift of the screw of 0.005 mm. Attached to the axis of the screw there is also a double turning knob. Fixed in a horizontal position at right angles to the drum is a metal plate marked off into a 0.5 millimeter scale. Within the box the micrometer screw butts firmly against the long end of a lever. With a leverage of five to one, the short end is attached to a bar which holds in position the right-hand wire. To take up all slack and lost motion a spring is fixed, one end to the movable bar and the other end to a position inside the instrument. The other three wires are maintained independently of the fourth and in fixed positions. The effect of the five to one leverage is to reduce the lateral movement transmitted through the micrometer screw to the right-hand wire to one-fifth that of the screw. One division, therefore, on the micrometer scale represents a lateral movement of that wire of 0.001 mm. or one micron.

Attached to the bottom of the metal stereoscopic box is a base plate of metal upon which the box can be tilted and fixed by a set-screw in any position from 90° to 180°. In the upper edge of the base plate is set an opaque milk glass to give an indirect uniform light background for the wires above it.

Behind the lenses is a shutter which is attached to a wire lever protruding through the upper right-hand side of the box. By manipulating the wire lever the examiner or the subject himself is able to produce practically an instantaneous view of the wires, which effect was found to be so valuable in the experiments of the six-meter apparatus.

Mathematical principles involved in the use of the instrument:

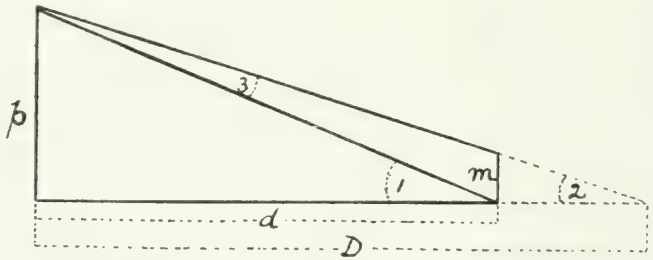

Fig. 7.—Diagrammatic representation of the binocular parallax:
Let p = interpupillary distance of lenses;
and m = the binocular parallax produced by turning the micrometer screw;
and d = the focal length of the lenses, or the distance to the apparently nearer wire;
and D = the imaginary distance to the apparently farther wire.
Angle 1 − angle 2 = angle 3, the binocular parallactic angle.

For any small angle, like angles 1, 2, and 3, the tangent and the angle in radians are practically equal, with negligible error.

Then tan angle 3 = r (angle in radians)

But tan angle $3 = \frac{m}{d}$

then $r = \frac{m}{d}$

or $m = rd$

If, for example, we let the binocular parallactic angle (3) = 1°, then 1° in radians = 0.01746 (which is an established mathematical equation). If also d = 137.5 mm., the focal length of the lens, then m = rd = 0.01746 × 137.5 = 2.4 mm. If 2.4 mm., therefore, represents the binocular parallax when we know the focal distance of the lens to be 137.5 mm., and the binocular parallactic angle to be 1°, we can readily tabulate binocular parallactic measurements representing any number of binocular parallactic angles desired, as

1° = 2.4 mm.
1′ = 0.04 mm.
1″ = 0.00066 mm.
1.5″ = 0.001 mm.

But it was planned that one division on the stereomicrometer scale would represent a lateral movement of the right-hand wire of 0.001 mm. Therefore each division on the scale also represents a binocular parallactic angle of 1.5″.

When the distance to the apparently nearer wire and the binocular parallax from the reading on the scale are known, then the formula $r = \frac{m}{d}$ may be applied directly, *e. g.*, when

$$m = 0.001 \text{ mm., then by substitution}$$
$$r = \frac{.001}{137.5} = 0.00000727$$

But 0.00000727 radian = 1.5″.

If, again, we desire to know the apparent depth-difference (D-d) represented by any binocular parallactic measurement which is read off directly in microns from the micrometer scale, the results are computed as follows:

$$\text{Tan angle } 1 = \frac{p}{d}$$

$$\text{tan angle } 2 = \frac{m}{d}$$

$$\text{tan angle } 3 = \frac{p}{D}$$

$$\text{then} \qquad \frac{p}{D} = \frac{p}{d} - \frac{m}{d} = \frac{p-m}{d}$$

$$\text{or} \qquad \frac{D}{p} = \frac{d}{p-m}$$

$$\text{and} \qquad D = \frac{pd}{p-m}$$

But p = 64 mm. and d = 137.5 mm.

If m = 2.4 mm. (the parallax of a binocular parallactic angle of 1°)
then by substitution $D = \frac{64 \times 137.5}{64 - 2.4} = 142.85$
and D-d = 142.85 − 137.5 = 5.35 mm.
When m = 0.04 mm. (the parallax of a binocular parallactic angle of 1′)
then by a similar method of computation D-d = 0.084 mm.
when m = 0.01 mm. (the parallax of a binocular parallactic angle of 15″)
then D-d = 0.0215 mm.
when m = 0.001 mm. (the parallax of a binocular parallactic angle of 1.5″)
then D-d = 0.00215 mm.

CONCLUSIONS.

The test is made by requiring the subject to set the wires into what he thinks is the same reference plane, *i. e.*, equidistant from his eyes. After a number of such trials the average error represents his binocular parallactic angle threshold. This threshold is computed in seconds by adding 50 per cent. to the reading on the scale, representing his average error. For example, if the scale reading is 10 divisions from the zero mark, then his minimal binocular parallactic angle is 15″. With such an instrument it is possible to classify individuals according to their respective degree of stereopsis. With those who have the ability of fusing stereoscopic objects, *e. g.*, nearly all those having binocular single vision, this classification should represent their respective ability to judge distance. This instrument should offer a far more satisfactory test of stereoscopic vision than the ordinary hand stereoscope, which has been used almost universally in testing candidates for aviation service.

The instrument perhaps offers a more direct application in testing and classifying candidates for the naval and artillery services, where, according to recent communications, the men may be required to use stereoscopic range finders. During the war it was known that the central powers used stereoscopic range finders almost exclusively. The entente powers, on the other hand, used various forms of coincidence range finders, but toward the end of the war the United States authorized the manufacture in this country of a number of stereoscopic range finders. The comparative results with the two forms of range finders will depend very largely upon the selection of the men using them. By means of the stereomicrometer it should be possible to select only those who possess the highest degree of stereopsis or judgment of distance. This group should show such a remarkable ability with the stereoscopic range finder that its use may eventually be adopted in place of the ordinary coincidence type.

A SIX-METER STEREOSCOPE.

Captain Harvey J. Howard, of the Medical Research Laboratory, Hazlehurst Field, Mineola, Long Island, N. Y., exhibited an improved apparatus to test at six meters the ability of candidates for the flying service to judge distance. In the paper read by Captain Howard (p. 195) a description was given of an apparatus designed to make such a test, and, although simple and crude in construction, the results secured were consistent.

The test was so planned that the only factor examined was the binocular parallax, which is the most important personal factor in the judgment of distance. The results obtained with the apparatus were in the form of threshold judgments of certain depth-differences. From these threshold findings, together with the measurements of interpupillary distances, the minimal binocular parallactic angles (Figs. 2 and 3, page 203) of all the subjects examined were computed (Table 1, page 216). It was recommended that a normal binocular parallactic angle be considered not larger than 8.0″ when employing a similar apparatus. Based upon the size of their respective angles, it was found possible to classify men into groups, indicating their degree of depth-judgment efficiency.

The findings obtained showed that fine discriminations in depth-perceiving ability were made possible by the apparatus. It, therefore, seemed advisable to employ the same principles in designing a more durable and compact apparatus, which would be simpler to operate and permit of two methods of experimentation, instead of only one. The first apparatus required the operator to stand beside it, adjust the objects, and lift a screen for each observation. In addition to this method it should be possible for the subject himself to adjust the objects into what he thinks is the same reference plane,

i. e., equidistant from his eyes. After a series of such judgments the average error would indicate his judgment threshold.

The apparatus recommended* consists of four essential parts: 1. An oblong box divided into two compartments

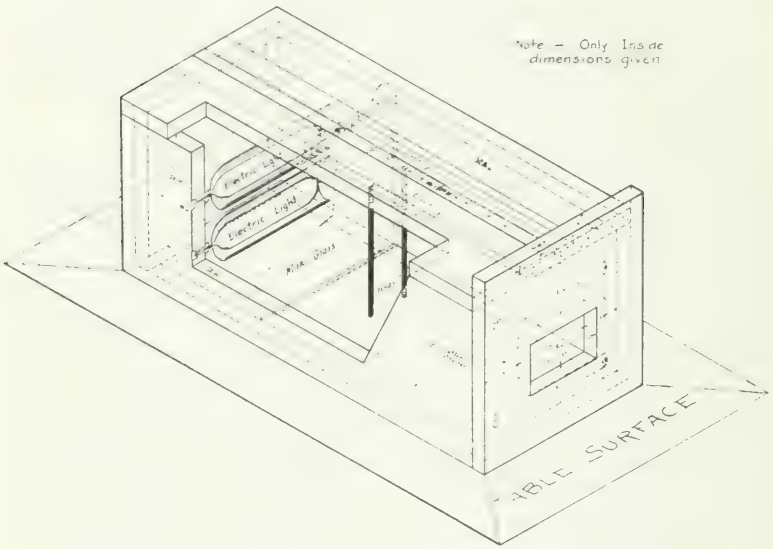

Fig. 1.—Perspective View of Six-meter Stereoscope.

with a window in one end. 2. A pair of round rods of equal diameter to serve as the test-objects. 3. A stationary scale for recording the position of the rods. 4. A mechanism for the transmission of motion to the rods.

Description of the Apparatus.—The box (Fig. 1) measures inside 60 cm. long, 24 cm. wide, and 20 cm. high. A vertical milk glass partition divides it into two compartments,

* Authority to make according to specifications granted June 9, 1919, to Bausch & Lomb Optical Co., by the Supply Department, Hazlehurst Field Mineola, L. I., N. Y.

the front 40 cm. long and the back 20 cm. long. In addition there is an elevation of the front end of 8 cm. above the top surface. This is for the purpose of screening the mechanism on top of the box from the view of the observer. One side of the box is made removable. In the middle of the front end is a window 8 x 12 cm. The interior surface of the front compartment, the margins of the window, and the anterior surface of the front end are all painted a dead black. The interior surface of the back compartment is painted a dead white. Near the rear of the back compartment are set two frosted, cylindric electric lamps connected to an ordinary wall plug. Each lamp has a reflector facing the front, to give high and equal illumination on the milk glass. Covering the window from behind is a Graflex shutter capable of any time exposure desired up to 1 1000 of a second.

In the top of the box are cut two parallel slits, each 12 mm. wide, extending from the front end to the milk glass partition. The lateral distance between the middle points of the slits is 6 cm.

The test-objects are two round wooden rods which are viewed through the window in the front end of the box when the shutter is open. Each of the rods is 18 cm. long and 1 cm. in diameter. In order to be exact duplicates they are made in a milling machine. At one end each rod is modeled to screw into a wooden or metal block which carries it in a vertical position along one of the parallel grooves. When set in the carrying block, the lower end of each rod is about 1 cm. from the floor, to give opportunity for unrestricted play and easy removal. The rods are painted a dead black or some other neutral color.

On top of the box is a millimeter scale which extends in the median line the length of the front compartment. The zero mark on the scale is located at the center of this compartment, viz., 20 cm. in front of the milk-glass partition.

The mechanism for the transmission of motion to the rods consists of several parts:

(*a*) Each of the two sliding blocks is 20 cm. long and 4 cm. wide, and is made to fit a groove cut in the top of the box. Three holes are drilled in the under surface of each block to receive a rod 1 cm. in diameter. This makes it possible to put one rod in the extreme anterior position on one block, and the other rod in the extreme posterior position of the other block, so that a total anteroposterior separation of about 36 cm. may be obtained. Attached to the upper surface of each sliding block, and opposite each one of the three possible positions of the rod, is a scale marker or indicator which projects toward the median line of the box over the millimeter scale. During an experiment only that scale indicator is used which has a test-rod opposite it.

(*b*) Each one of the blocks is propelled by a rack and pinion located on the top of the box. To the shaft of each pinion are attached a pulley wheel and a turning knob. Just behind the front elevation, at the midpoint, is a coordinating triple wheel pulley. One wheel carries a cord from the pulley of the right rack and pinion shaft, the second a cord from the pulley of the left rack and pinion shaft, and the third a cord from a pulley wheel which is attached to a table six meters away from the center of the front compartment. Two holes in the front elevation are bored to receive the cord from this pulley on the table.

(*c*) In order to prevent the emission of light through the slits in the top of the box ribbons about 2.5 cm. wide are attached to the sliding blocks and run over wheels.

The Two Methods of Employing the Test. (1) A subject sitting at the table with his head fixed in a head-rest may move the rods by simply manipulating the turning knob of the pulley wheel attached to the table in front of him. As a preliminary to each observation the examiner sets the rods at unequal distances from the subject's eyes. The shutter

is then opened, and the subject adjusts the rods into what he considers is the same reference plane, *i. e.*, equidistant from his eyes. After a number of such trials the average error is recorded as his depth-difference threshold.

(2) In the second method the cords are removed. The examiner adjusts the rods and raises the shutter the same as before, but the subject is required to state which rod is nearer to him, the right or the left. The rods are first placed at a depth-difference of 30 mm. If the subject makes several judgments at this station correctly, the rods are placed successively at smaller intervals apart until the subject no longer is able to perceive a difference in distance. The shortest depth-difference at which he is able to judge correctly not less than 75 per cent. of the trials is recorded as his depth-difference threshold.

Principles and Formulæ Involved. For an understanding of the term "depth-difference" see Figs. 2 and 3, page 203. It will be observed that the greater the depth-difference, the greater will be the binocular parallax. Table 1 is a computation of binocular parallactic angles based upon interpupillary distances ranging from 57 mm. to 72.5 mm., and upon depth-differences ranging from 5 mm. to 360 mm., when the near object is six meters distant.

GERMAN FIELD OPTICAL OUTFIT.

In the exhibition of the outfit, Dr. Allen Greenwood said:

"At the meeting of the Section on Ophthalmology of the American Medical Association I showed a large case, such as the Germans used in their field outfit. It was rather cumbersome to bring here, so I have just a few articles from it, which I thought you might like to see. One is the rough frame used by the Germans for their field work. The large square case had a double drawer. Here is a trial-frame for holding lenses. It is not fastened to the head but just held

in the hand as a lorgnette. The frame was to be used inside the gas mask. The tray of the outfit was filled with several hundred cut and edged lenses, to be fitted into this unpolished frame. There are different sized nose-pieces to use. The German lenses for the soldiers were ground with toric curve, while those we employed were made flat. The latter were just as good, however. At the Section meeting some criticism was made of the frames that took round lenses. Major Edmunds has informed me that all the round frames came from the manufacturer to his shop, with a plug to lock the lens. The plug screws in, and I imagine that this method or a similar one of locking lenses will be adopted by all manufacturers."

NON-OPERABLE TUMOR OF THE ORBIT AND BROW, TREATED SUCCESSFULLY WITH RADIUM. REPORT OF A CASE WITH A FEW REMARKS.

GEORGE HUSTON BELL, M.D., AND (BY INVITATION)
SINCLAIR TOUSEY, M.D.,
New York.

Skepticism in regard to the value of radium in the treatment of malignant and non-malignant tumors is fast disappearing. It is now generally recognized by surgeons of the largest clinics that radium is a great therapeutic agent and a valuable adjunct in the treatment of cancerous and precancerous growths. For these reasons we decided to try radium with this patient.

A woman, aged sixty-five years, came to Dr. Bell's clinic at the New York Eye and Ear Infirmary on December 13, 1917, with the following history: nine months before she ran into a door-jamb and struck her forehead a severe blow on the left side.

The first thing she noticed was a lump on her forehead, which at times gave her some pain. She went to Bellevue Hospital, where she was treated in the Out-Patient Department for six months with antisyphilitic treatment, although her Wassermann at that time was negative.

After the swelling on the forehead became more noticeable she observed that her left eye became more prominent than the other one, and the upper lid began to swell. The tumor got larger and larger, the eye more prominent, and the pain increased. Finally she was sent to the New York Eye and Ear Infirmary for treatment.

Status Præsens.—Her whole head and face was enveloped in a black veil; on removing it, she presented a ghastly

spectacle. Under the bandage, which was soaked with blood, was an enormous tumor of the orbit and brow. The cornea had ulcerated and perforated, and the eye was bleeding freely. The globe was markedly proptosed. The tumor had pushed out of the orbit the eyeball, which was displaced downward and inward. There was a solid tumor filling the orbit, which extended well over into the frontal bone. The upper lid was greatly swollen, and the tension was so great that it could not be elevated. The eyebrow and the skin of the forehead were greatly stretched. The cornea could be seen projecting between the eyelids. (See Fig. 1.) This was taken on her first visit to the hospital and will give you some idea of the growth.

The patient was ordered into the hospital at once. She was so weak that we did not try to get a section of the growth for the laboratory.

An *x*-ray of the skull, including the teeth, was ordered, also a Wassermann.

Previous History.—Married and four children, all of whom are living. Had not been sick in twenty years. Had never had a miscarriage. The last sickness that she remembers having was typhoid fever.

Dr. Dixon's report of *x*-ray findings of skull: Frontals about proper size; right fairly clear; left rather hazy, due to overlying tumor. Left orbit seemed filled with the growth, and there was a soft-looking area in the frontal bone above the left orbit. Antra were fairly clear. Sphenoids were large and did not seem to be involved.

X-ray of teeth shows considerable amount of alveolar absorption with what appears to be a cavity around the almost completely absorbed roots of the upper bicuspids, and some absorption at the roots of the molars.

On inspection of the mouth we could see that her gums were not pink, firm, and healthy-looking, but were purplish and swollen and there was a red line adjacent to the teeth. We decided that she had a dirty mouth and we had all her teeth (12) extracted. The report on her Wassermann was negative. This was the second negative report.

The patient was shown by Dr. Bell at a meeting of the New York Ophthalmological Society, and also at the Section of Ophthalmology at the New York Academy of Medicine.

FIG. 1.
Taken December 14, 1917.

FIG. 2.
Taken March 13, 1918.
Note the marked reduction in size of tumor, also expression of face since extraction of all the teeth.

FIG. 3.
Taken May 4, 1918, six months after treatment was instituted.
Cosmic result now about perfect.

All the oculists who saw her advised against an operation. It was then that we decided to use radium, and Dr. Tousey very kindly offered to treat the patient, and to use his radium salt. The first treatment, which lasted one hour, was given on December 19, 1917.

Applications were made of 20 mgm. of radium salt of 2,000,000 activity. This was inclosed in a sealed glass tube, that again in an aluminum treatment tube, that in a lead wrapping about $\frac{1}{10}$ inch thick, and that finally in the soft-rubber cover from Oberlander's urethrometer. The radium was left in one place for an hour at each treatment. The places were $1\frac{1}{2}$ inches apart and at first the tumor was so large that there were six of these areas to be treated, one each week. Two weeks from the first treatment decided shriveling of the skin was to be noted, and the patient was sure the tumor was smaller, The surface was of less and less extent, so that toward the end only two places received the application, one above and one below the supra-orbital margin. At no time was there any cutaneous reaction, but, on the contrary, a steady change from the original glistening appearance to that of healthy skin. The first treatment was on December 19th, and the last on April 1st.

The treatments were continued every week by Dr. Tousey, and on March 13th the second photograph was taken. The improvement was so great, and the reduction in the size of the tumor was so progressive, that we were encouraged to go forward with the treatment. Fig. 2 shows that all the teeth had been extracted.

On April 1st Dr. Tousey pronounced her cured. There was a shrunken globe remaining, which was enucleated under local anesthesia.

The last photograph (Fig. 3) was taken May 4, 1918, after the glass eye had been inserted.

Dr. Bell saw the patient again on January 1, 1919. She had had no recurrence of the growth and had gained twenty pounds in weight. This patient had no internal treatment.

The cosmetic result is now about perfect (Fig. 3). The clinical diagnosis of sarcoma was made by us. We are sorry that we have no laboratory report to offer; the patient was so weak and feeble when first seen by us that we did not

feel like torturing her any more. However, we feel confident about the diagnosis.

Zinzi,[1] of London, reports a case of orbital sarcoma successfully treated by radium, which had recurred twice, once after enucleation and again after a growth from the orbit had been removed. A dose of one hundred and fifty milligrams of radium bromid was first used, then 200 mgm. Zinzi was so well pleased with this result that he showed the patient on May 5, 1916, before the Ophthalmological Society of the United Kingdom.

Aikins,[2] in reviewing radium as a therapeutic agent, speaks of its great value in rodent ulcers, vernal catarrh, and exophthalmic goiter.

Some of the most careful work has been done by Axenfeld.[3] He reported, in 1915, results obtained after treatment by radium, of a case of glioma in a child whose right eye had been removed for glioma. At the time of enucleation of the gliomatous eye, three foci of growth, one rather large, were seen in the left eye. Radium treatment was instituted. He made eleven careful fundus examinations, noting the decrease of the growth, and in eighteen months after the first treatment reported that one area had disappeared, another was almost gone, and the third, the largest one, had very much decreased in size. In 1916 he reported further progress in this case. The largest growth had completely disappeared, leaving only an evidently dead preretinal trace, with no recurrences elsewhere. Axenfeld was able to demonstrate to his own satisfaction the good effects of radium in the treatment of the glioma.

In conclusion Axenfeld holds that blind gliomatous eyes should be excised, but that for commencing glioma in the still seeing eye, radium is not only justifiable, but obligatory.

C. F. Clark[4] treated sarcoma of orbit by inserting a tube of radium in the orbit after canthotomy and division of external

rectus. The radium was left in four hours, and this was repeated every two weeks. The proptosis quickly receded, and in two years the case was apparently cured. It is interesting to note that a nuclear cataract developed after six months of the treatment, perhaps due to the radium.

Recently S. Gifford[5] reports a case of leukosarcoma of the iris treated by radium. He concludes by saying that in tumors of the iris, treatment by radium should be seriously considered where the growth is not especially rapid. Even if it has reached the iris root such treatment should be offered to the patient as an alternative to operation, he being observed carefully during each treatment. Where operation is refused, it would seem only just to the patient to very urgently advise radium.

Heckel reported[6] a case of melanosarcoma of the orbit treated with radium which was held in abeyance for two and a half years.

We have treated five cases of vernal catarrh with radium, the plaques have completely disappeared, leaving no scars at all, and so far there has been no recurrence after two and three years.

Conclusions.

We cannot lay too much stress upon the use of radium in all tumors of the eyelids, orbit, and brow, when syphilis can be excluded, and we hold that it should be given a thorough trial by competent observers before resorting to surgery.

We also feel that radium should be used in tumors of the iris, when syphilis and tuberculosis can be excluded, before resorting to surgery. Most especially do we recommend the use of radium in these iris tumors where they are growing slowly, and where we can keep a close observation of the patient. In the treatment of all intra-ocular tumors radium should be seriously considered.

We are of the opinion that radium is the most effective

agent we have in the treatment of epithelioma of the eyelids, as it is easily controlled as to dosage and effect.

We look upon radium as a specific in spring catarrh.

We hold and claim that radium has great value as a therapeutic agent, but before instituting treatment in any given case we claim that all the sources of focal infections must be cleared up and eliminated. The established value of radium we think is now pretty well recognized, although it is not used by ophthalmic surgeons as often as one would suppose.

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DISCUSSION.

DR. T. B. HOLLOWAY, Philadelphia: Dr. Bell has referred to the use of radium prior to operations on tumors of the orbit. I think that much would depend on whether the orbit is the primary seat of the growth or whether it has been encroached upon from neighboring structures. To my mind, radium may well supplement operative procedures, probably better than operative procedures may supplement radium, in certain types of tumor formation. I reported some years ago the history of a case of sarcoma with bilateral orbital involvement, in which, immediately after the operation, radium was packed into the orbit with the primary dressing, 25 milligrams being allowed to remain for eight hours. That procedure has been used in another case, which was inoperable and where adjacent structures were involved. The patient was under treatment by Dr. Pancoast, and I think the treatment prolonged the patient's life, although the result was inevitable. Since then, radium was used in another patient who had an inoperable carcinoma involving the tem-

poral region. At times evisceration of the globe may seem preferable to exenteration of the orbit. Such was the case with this patient, but local applications of radium, interspersed with *x*-ray treatment, was kept up in all the cases referred to. The history of another patient, an Italian, observed three years ago, already has been reported. The growth was an epithelioma of the lids which had involved the orbit, and good results were obtained by the application of radium after curettage and exenteration of the orbit; the patient, however, is still under observation.

DR. C. F. CLARK, Columbus, Ohio: Five or six years ago I ventured to use radium in an orbital growth in which I was making an exploratory incision. On examination the growth proved to be vascular, that is, a large mass of distended vessels was found to occupy the apex of the orbit. The patient was a child of two and one-half years. This was before the use of radium had been so well developed as is now the case, and we did not then understand how to protect the tissues from its ill effects. I used it without protection around the tube. I had already made a canthotomy and detached the external rectus, and by means of a speculum was able to obtain a fair view of the deeper portion of the orbit and the vascular mass. Dr. J. F. Baldwin, who happened to be in the operating room, suggested radium and kindly allowed me to use his tube. I embedded it in the mass and left it in place for two or three hours and then removed it. A few days later I repeated the process. The effect on the tumor was excellent, and the eye receded. During the examination preceding this operation it had been discovered that there was evidence of quite complete paralysis of the optic nerve. It was apparent that there was no vision in the eye, and, as our object was to avoid evisceration of the orbit with the consequent deformity, it made no special difference in this case if the nerve were affected by the radium. But the patient later developed a zonular cataract apparently due to the radium. I should like those who can to tell us what experience they have had in this respect; and whether, in using radium in this field, we could guard ourselves against such accidents.

I have in my possession a specimen of a melanosarcoma of

the choroid for which the eye was removed after the use of radium for a long period. Its use apparently influenced the progress of the growth for a short time, although it had no permanent effect, and ultimately enucleation was necessary.

Dr. Robert S. Lamb, Washington, D. C.: I have relied on the *x*-ray to control and supplement operative procedure. It seems to me that extensive growths may be removed, even if we are unable to control the cosmetic result. Several years ago I operated on a man with large orbital growth, using the cautery alone, the knife cautery outlining the mass, and going back into the orbit through the ethmoid and sphenoid sinuses and down into the antrum. The man's life was saved, and he is still living.

Dr. Dunbar Roy, Atlanta, Ga.: I should like to ask Dr. Bell what was the duration of the treatment.

Dr. Derrick T. Vail, Cincinnati, Ohio: I desire to mention the case of a man, aged eighty-four years, whom I first saw ten years ago on account of slight exophthalmos of the right eye associated with ophthalmoplegia externa and partial ptosis. There was opacity in each lens, and the vision was reduced in the affected eye to 20/100. He had never possessed robust health. The growth in the orbit behind the eyeball slowly increased, and the ptosis and ophthalmoplegia externa grew worse. Last September he presented complete ptosis, marked exophthalmos, total paralysis of motion, and absolute blindness of the right eye. Moreover, he presented the picture of senility, but was mentally bright. Although having no pain, he was desirous of being relieved of the tumor. I told him that I could exenterate the orbit and relieve him of the tumor, but the deformity would be great, and I doubted in the frail state of his health that operation would be wise. I advised him to go to Johns Hopkins Hospital and try the radium treatment. He went, and I did not see him until February, 1919. The tumor-mass was entirely gone. The growth of the orbit had enlarged the orbital cavity until it was one-third larger than normal. This permitted the eyeball to recede so that there was a suggestion of enophthalmos. His ptosis and ophthalmoplegia had partly disappeared. The eye regained perception of light. I do

not know the character of the growth. It must have been benign or semi-malignant. I made a tentative diagnosis of cylindroma. Whether malignant or non-malignant, the cure was complete. I believe that radium treatment would not be so desirable for cases of glioma. If glioma can be diagnosed before it had produced increased pressure, it would be better to enucleate at once rather than to try to cure it with radium.

Dr. George H. Bell, New York: In regard to what Dr. Holloway stated, I would say that I think that it is better to use radium first, then it may not be necessary to operate. If an operation is necessary, radium may be employed afterward.

In regard to Dr. Clark's remarks, I would state that, so far, we have not had any cataracts from the treatment of the tumors with radium. Dr. Tousey has a peculiar way of applying the radium. He has had much experience, and perhaps that has had something to do with it.

In answer to Dr. Roy's question, I saw the woman eight months ago, and she was in excellent health and had gained 20 pounds in weight.

Dr. Vail's case is unusual, and encourages all who are interested in treatment with radium. It is a great therapeutic agent and one that is well worth trying. Dr. Tousey has had some remarkable results, and thinks that all these tumors can be absorbed by its use.

A POSITIVE FOCAL TUBERCULIN REACTION IN A SPINDLE-CELL SARCOMA WHICH HAD PERFORATED THE SCLERA.

J. W. CHARLES, M.D.,
St. Louis.

On July 3, 1918, B. M., aged twenty-four years, a soda-water clerk, came with the following history: Eight or nine years ago the right eye had been burned by powder. It had never given any discomfort until five years ago, when the eye had been attacked by deep pain and the patient had been compelled to stay in a darkened room. At that time he was told by an ophthalmologist that nothing could be done for his vision, which was then nil. The vision of the left eye proved to be 23/19.

Inspection of the right eye showed a ring staphyloma over the ciliary region in its entire upper half. At the upper limbus there was a hazy spot on the cornea, the remains of a rather superficial parenchymatous keratitis; also an almost total exclusion of the pupil, in which could be seen a cataractous lens. Movement of the eyes in all directions revealed nothing until the patient looked up, when a small lump was seen on the lower inner quadrant of the sclera, which seemed to originate behind the equator, was invisible in ordinary fixation and which moved with the globe. From its curvature its diameter was estimated at 1 cm. Upon interrogation the patient stoutly maintained that he had first noticed it at least one year ago, and he felt sure that it was nearly eighteen months. This fact and the evidences of the old keratoscleritis compelled one to think first of all of tuberculosis, because of the fact that usually progress is much more rapid after a perforation by a malignant tumor than had taken place in this case. There was no evidence or history of syphilis, and the Wassermann reaction by Dr. Buhmann was found to be negative with the most sensitive antigen. The

patient was referred to Dr. Albert E. Taussig for a diagnostic injection of tuberculin on July 5th. He found no evidences of tuberculosis in the physical examination, and gave a subcutaneous injection of three milligrams of AT. There was no evidence of a reaction until the early morning of July 8th, when the patient began to have great discomfort, breakbone aching, and temperature of 100.8° F. The lump on the sclera was much larger, its estimated diameter being $1\frac{3}{4}$ cm.; it was red, with a second lobe appearing behind and below it.

After a disappearance of several weeks the patient returned with the report that he had been sick in bed for four days with a high temperature, but no symptoms in the respiratory tract (we had naturally thought of influenza). The patient was so loath to have an enucleation performed, although the eye was blind, that a tentative diagnosis was made of a perforating solitary tubercle and the patient was referred to Dr. Taussig for treatment with tuberculin. This was begun with 0.001 mg., increasing the dose until August 24th, when the patient seemed to have a mild focal reaction after receiving 0.035 mg., the growth measuring $1\frac{1}{2}$ cm. There was no increase in temperature, and a week later the patient confessed that perhaps late hours and joy-riding made his eye red and swollen. Dr. Taussig went on his vacation, leaving the patient with Dr. Ross, who continued to give tuberculin injections in increasing doses without any effect until the return of Dr. Taussig, October 7th, when 10 mg. were injected because no reaction had followed the administration of smaller doses up to 3 mg.

On the following day the growth was much redder, with lacrimation, and its apparent dimensions were $1\frac{3}{4} \times 1\frac{1}{2} \times \frac{1}{2}$ cm. In Dr. Taussig's opinion, "No doubt about a focal reaction."

The patient was immediately sent to the hospital for enucleation. After the conjunctiva had been loosened, the external rectus and the superior muscles were severed, and then the optic nerve, thus shelling out the globe without injury to the tumor. This method disclosed, next to the nerve, a round tumor about the size of a pea, connected with the middle lobe of the main growth, and which had existed unsuspected until the operation. Frozen sections

from this lobe made by Dr. Ives showed an undoubted spindle-cell sarcoma. No pigment could be found in the sections.

An orbital exenteration was performed by Dr. L. C. McAmis, after which a very small focus of tumor spindle-cells was found in one of the extrinsic muscles.

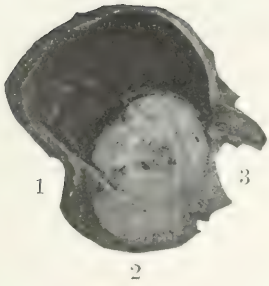
A course of Coley's fluid was then instituted, beginning with $\frac{1}{4}$ of a minim and increasing at first $\frac{1}{4}$ daily, then in larger doses until November 5th, when 2 minims were given. This was followed by a slight reaction with temperature of 99.8° F., pulse 88, and respiration 22; and again on the eighth, when the temperature was 99.5° F., pulse 90, respiration 20.

On November 12th, with $2\frac{1}{2}$ minims there was no reaction, nor on the fourteenth with 3 minims, and the sixteenth with $3\frac{1}{2}$ minims; but on the eighteenth, with 4 minims, the temperature was 99° F., pulse 74, respiration 20. Coley's fluid was continued every other day in increasing doses until December 3d, when $7\frac{1}{2}$ minims were given without reaction. The patient was then allowed to return home under the care of his physician. The orbital cavity has now almost completely filled out, is well covered, and eight months after the exenteration there has been no recurrence.

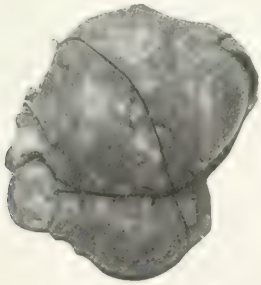
Dr. Ives's report follows: "The specimen consists of an eyeball and a tumor adjacent to it. The surface of the tumor is exposed, excepting on the aspect adjacent to the eye. The surface is smooth. The tumor is 23 millimeters long and 15 millimeters in its broadest diameter. It is divided into three lobes by shallow fissures perpendicular to the longest diameter. The central lobe is the largest. The tumor is rather firm, and the cut surface is gray-white. There is no gross evidence of areas of necrosis.

"Sections show closely packed spindle-cells with elongated nuclei. The cells are arranged in bundles placed at various angles to one another. Intracellular substance is inconspicuous. A few blood-vessels with thin walls were noted. Mitotic figures are fairly common. Diagnosis: Spindle-cell sarcoma."

Orbital tissue: "The tissue was examined grossly and one portion suspicious of tumor was taken for sections. This shows what I consider to be spindle-cell sarcoma."



Lateral view of halved globe and tumor, the posterior lobe of which has been used for sections. The anterior lobe was not well illuminated. 1. Anterior lobe. 2. Middle lobe. 3. Sectioned posterior lobe.



Lateral view of eye and tumor in which the sectioned posterior lobe has been replaced by a piece of paraffin.

Upon halving the globe in such a manner as to include the nerve and tumor in the same sections, the vitreous cavity was found to be about one-third occupied by an almost round white growth which had detached the retina, of which there is left only a strand of tissue from the nerve to the region of the lens. The growth is situated in the lower and nasal portion, and the line of the sclera can be distinctly followed in the tumor.

The fact that our ophthalmic technician is still busy in the service has prevented a histologic examination of the whole specimen, and we have been compelled to be satisfied with the undoubtedly correct diagnosis by Dr. Ives from the sections taken from the smaller posterior lobe.

A positive focal tuberculin reaction in a tumor originating in the uveal tract is explainable by considering the vascular supply of the growth. Evidently this patient had a uveal tuberculosis which gave a positive reaction, which for our purpose means a congestion in the uvea that simply extended to the tumor. Strictly speaking, then, the tumor itself was not positive to tuberculin, but only the tissue from which it derived its blood-vessels.

The spindle-cell sarcoma is the least malignant of sarcomata and, therefore, we have more hope that Coley's fluid will avail in preventing recurrence. The patient was seen ten days ago with only a very small sinus remaining open.

It goes without saying that all such blind eyes, in which there is any doubt whatever about malignancy, should be enucleated at once for diagnosis. Taking portions of any tumor for diagnosis is a dangerous practice, but the apparent extreme chronicity in the course of this tumor and apparent focal reactions to begin with, followed by the certain focal reaction October 7th, were misleading.

CLINICAL AND PATHOLOGIC REPORT OF A CASE OF INTRAOCULAR TUMOR.

HOWARD F. HANSELL, M.D.,
Philadelphia.

The paper read before this Society at its meeting last year by Dr. Harry Friedenwald, and the discussion thereof, call attention to the difficulties in the diagnosis between malignant and non-malignant inflammatory tumors in the vitreous chamber. The practical question intimately connected with the determination of the diagnosis is the line of treatment to be adopted in an individual case. Rarely may the growth before enucleation be declared malignant. The exceptions are those cases which are rapidly growing, with ruptured ball, and extension to neighboring tissues. It is in the early stages, when enucleation may prevent metastasis, that the diagnosis is most important. The ocular conditions which interest us in this stage are:

1. *Separation of the Retina.*—Our first thought in the presence of retinal detachment, in which high myopia or traumatism have no causative influence, is of choroidal sarcoma. The retina, when detached by a growth, presents characteristic appearances which need not be dwelt upon. The difficulty in making a positive diagnosis lies in determining whether the floating and undulating retina may have been originated by a tumor which has become concealed by edema or extensive serous exudation. The extent and situation of the detachment are of only slight diagnostic value. On the other hand, close observation of the course of the detachment extending, if possible, over several weeks or even months, and including frequent measurements of the

visual fields, is most helpful. A gradually increasing area of blindness almost positively indicates tumor, whereas extensive fluctuations or an unchanged area point to other causes.

2. *Intraocular Tension.* Difference of opinion prevails as to the diagnostic value of this sign. It may be assumed that until the lens is pushed forward, the anterior chamber shallowed, the iris dilated and unresponsive, in other words, the glaucomatous stage, the tension is normal or nearly normal. It is true that the intraocular contents are increased by the extraneous tissue, at least in number, but that there is actual or permanent increase in tension by this new tissue is subject to question. The condition is not unlike that in retinal or vitreous hemorrhage. Here the blood is actually an additional content, but unless its volume is excessive and has disturbed the relation of intraocular secretion and excretion, plus tension has not been noted. The intraocular changes incident to or causative of hemorrhage may easily lead to minus tension. Almost uniformly, in spontaneous retinal detachment in which the subretinal space is occupied by fluid, the tension is below normal, and yet new material has been added to the intraocular contents without increasing the sum total of contents, if one may depend either on the tactile sense or the tonometer. Only when the normal relation between intraocular secretion and excretion is altered, or when the ball contains more than its normal capacity which is subject to slight variation, in other words, when the eye becomes glaucomatous, is tension permanently increased. In the diagnosis of tumor, therefore, plus tension is not primary but secondary to the glaucomatous stage.

Transillumination.—In making use of the transilluminator the room should be dark and the observer must critically study the pupillary reflex from every direction. It is not enough that he should make his decision from the most accessible or comfortable position, especially in the case of

small tumors. This observation has, I believe, not been previously made or at least emphasized. Without changing the contact of the transilluminator the pupil may appear dark to one observer and show the reflex to another. The explanation is to be found in the lack of uniform density of the tumor and the condition of applying the light at or near its edge. The test is of great diagnostic value only in those cases in which the tumor lies in the anterior half of the ball, for one outside the accessibility of the instrument will, of course, cast no shadow.

Metastasis to the skin and internal organs has been noted in one-third to one-half of the cases. Early enucleation is no preventive. Recurrence of the growth in the orbit is uncommon provided the ball has been enucleated before its external walls have been broken through. After the orbit has been invaded recurrence, especially in the small round-cell form, is to be expected. My own experience has been particularly fortunate in that I have not seen a single case of metastasis from the eye to any of the internal organs, and I am inclined to believe that the fear of metastasis is exaggerated.

Clinical History of Case.—Mrs. P., aged thirty-nine, came to the Jefferson Hospital in October, 1918, complaining of loss of vision in left eye during the preceding few weeks. She had no pain, headache, or disturbance of general health, and had suffered no traumatism either to the eye or body. The eye was not injected, the cornea clear, anterior chamber of normal depth, the iris slowly responsive to light directly and consensually, the lens clear, tension normal, and the ciliary region not sensitive to touch. The retina was detached in its entire extent except upward and inward. The perception of light was confined to the lower temporal field. During the next six months the patient was observed every few days and the following changes noted: From the beginning there were evident a large number of small straight vessels just behind the lens and in the lower part of the de-

tachment, which during the course of the disease did not change in number or position. The retina remained fixed throughout. No tremulousness or waving could at any time be noted. The anterior chamber gradually decreased in depth until at the last the iris was in contact with the cornea at many places. The pupil was small and immobile, dilating slightly after the instillation of a mydriatic. Tension remained unchanged until toward the last, when it gradually rose, and before enucleation the ball became undeniably hard. The eye was singularly free from injection until the last week, when the deep ciliary vessels became prominent. From the first observation until the last transillumination indicated a tumor in the temporal fundus. When the light was applied to the temporal area of the ball, no reflex could be seen; at all other points the reflex was distinct. During the last week the patient complained of deep-seated pain in the eye and adjacent temple and forehead. Dr. G. Oram Ring, who has observed the case with me almost from the beginning, agreed with me that the time had come for enucleation. On April 3d the eyeball was removed and a gold ball implanted in Tenon's capsule.

Pathologic examination was made by Dr. E. D. Funk, to whom I am indebted for the following report. The specimen consists of an eye measuring 2.5 by 1.3 cm.; weight, 9.5 gm. The cornea is somewhat hazy, protrudes, and appears to be under increased tension. The lens appears as a grayish, opaque body when viewed through a magnifying glass. The iris manifests no macroscopic change. Under transillumination half of the eyeball appears relatively clear while the other half is dark. After fixing the eyeball in a hardening solution, a cross-section reveals a rather extensive detachment of the retina covering more than half of the eye. Midway between the cornea and entrance of the optic nerve is a pigmented, rather soft mass arising from the choroid coat and extending into the vitreous humor for 0.5 cm. at its farthest point. On serial sectioning a number of pin-point hemorrhagic areas are seen. The growth has pushed the retina forward.

Fixation, formalin; usual laboratory stains.

Histology. The growth has displaced the basal lamella and retina into the vitreous; it is very vascular, and composed

mostly of large collections of spindle-cells closely arranged and within a very fine and scanty intercellular stroma. In some places the cells appear polyhedral in type, and here they suggest an alveolar arrangement. The vessels are fairly numerous, small, and well filled with red cells. Near the edge of the growth are a few small hemorrhagic areas. Pigmentation is patchy throughout the tumor, being most marked along its origin. This pigmentation appears to be primary and not hematogenous.

Diagnosis: Melanotic sarcoma.

TWO CASES OF EPITHELIOMA OF THE EYEBALL AND LIDS. OPERATION. NO RETURN AFTER SIX YEARS.

DUNBAR ROY, M.D.,
Atlanta.

CASE I.—W. A. F., white, farmer, age fifty-four. On June 10, 1908, this patient consulted me on account of a continued irritation and inflammation in his left eye. The family history showed that the father died of cancer and one brother has had cancer of the face, but was cured by operation.

Present History.—Has always been strong and healthy. The eyes have always been good until six years ago, when the left eye became inflamed. This has continued ever since with various exacerbations, always becoming worse during warm weather.

Examination.—Left eye: Considerable irritation and redness of both the bulbar and palpebral conjunctiva. Some catarrhal secretion. At the sclerocorneal margin below and to the nasal side there was an elevated gelatinous mass which resembled those seen in severe cases of vernal conjunctivitis. Blood-vessels were numerous and radiated from the conjunctiva into this mass. The whole sclera was congested. The pupil responded to light and accommodation. The central portion of the cornea and the upper outer quadrant

were perfectly clear. There was no pain, but some lacrimation. The haze in the cornea extended slightly beyond the edge of the gelatinous growth. Vision was 20/50. The vision was normal in the right eye and there were no signs of irritation.

Suspecting this growth to be an epithelioma the writer removed the same as thoroughly as possible under cocain, and submitted the specimen to the Pathological Laboratory of Emory University. The report received confirmed the clinical diagnosis of epithelioma. The eye healed well but considerable irritation persisted. The patient was then placed under Dr. Hodgson's care, who used 10 milligrams of radium as a local application. This treatment was continued at intervals for several months without any material results.

On February 24, 1909, eight months later, a thorough examination was again made. The patient was suffering with more pain, and the whole eyeball was much congested. The gelatinous growth had recurred on the cornea and had extended still further toward the center, so that there was very little clear cornea remaining. Vision was reduced to 20/100. There was more infiltration in the conjunctiva, showing some extension of the growth in this direction. We then decided to enucleate the eye. This was done under ether anesthesia, and at the same time nearly all the bulbar conjunctiva was removed. The cavity was slow in healing, and even the small amount of conjunctiva left began to infiltrate. A piece of this was excised and submitted for examination, which also showed the epitheliomatous changes.

On March 3d, two weeks later, the whole orbital contents were exenterated, leaving the upper and lower lid with every vestige of conjunctiva and cartilage removed. With the cilia removed from the free edge, the lids were turned back into the orbit and retained there by packing. The cavity healed perfectly, and the denuded bone deep in was finally covered with epidermis.

This patient was seen one year ago, and there were absolutely no signs of a return of the growth. His general health was excellent, and the whole orbital cavity was smoothly covered with skin. It has now been eleven years since the operation and the result still remains excellent.

CASE II.—Mrs. Jno. W., white, age thirty-three. November 13, 1913, this lady was referred to me by a dermatologist on account of an epitheliomatous growth extending from the lids to the eyeball.

Family history negative. Personal history shows that the patient has always been strong and healthy up to two years ago. At that time she noticed a small ulcer at the inner canthus of the left eye, at the junction of the skin and mucous membrane. This gradually increasing in size, she consulted a dermatologist. His report showed that there was a negative Wassermann, and a portion of the growth excised showed a typical epithelioma. The patient was then treated constantly, with varying success. Sometimes the growth would nearly heal and then break down. The treatment consisted of pastes, *x*-ray, and radium, changing from one to the other as the conditions demanded. For the last month it has not improved and is beginning to involve the conjunctiva, hence this case was referred to the writer.

Examination.—The patient shows absolutely no signs of cachexia, which I think is perfectly characteristic of this class of malignant growths. A good portion of the lower lid shows a scaby ulceration, on the dermoid side, of varying extent and form. Its clinical appearance was that of an epithelioma. On the mucous membrane side there were old cicatricial scars causing adherence to the ball. The globe itself was red and irritated. The growth had also extended around the dermoid surface at the inner canthus and had involved the upper lid. This also showed cicatricial adhesions of the inner surface of the lid to the globe. The patient was suffering intense pain with her eye and there was a marked superficial keratitis. After consultation it was decided that a thorough evisceration of the orbital contents, together with an extensive removal of the adjacent skin, offered the only hope of relief.

On November 15th, two days after my first examination, the writer performed this operation under ether anesthesia. A circular incision was made around the rim of the orbit so as to include both upper and lower lids. Internally, toward the nose, the skin was removed well outside of the growth. The whole orbital contents were exenterated to the apex. All oozing was checked by hot gauze compresses. The whole

surface was swabbed with a strong solution of chlorid of zinc, followed with a packing of iodoform gauze. This dressing was not removed until the sixth day. The cavity looked healthy, and the edges of the cut surfaces were beginning to granulate. She remained in the hospital two weeks, following which she was brought to my office for the dressings. The same dressings of iodoform gauze were continued every three days with a complete relief of all pain and a healthy healing of the denuded surface. It was remarkable how quickly the cavity from the cut edges began to epidermatize.

January 6th, nearly two months after the operation, the appearances were excellent and the skin surface was rapidly extending to the apex. By May 1st the whole cavity was covered with healthy skin. Just at the apex there was a little moisture. I then advised all dressings to be left off and that the patient expose the cavity for one hour every day to the direct rays of the sun. In two weeks the cavity looked normal. She then passed from under my observation, and the dermatologist advised me that two months later the inner wall of the orbit looked a little moist and irritated. This was treated with the *x*-ray, which produced a rapid healing. Since that time, now six years, the patient seems apparently well. I say apparently, for time alone can determine whether the cure is permanent.

Remarks. Squamous epithelioma seems to be the only form of carcinoma which offers any chance of cure. Some good results have been reported from the use of the *x*-ray and radium. It is a well-known fact that many cures of epitheliomata of the face have been reported where thorough excision with the knife has accomplished this result. Borch believes that epitheliomata of the limbus arise from the same type of epithelioma that is found in the skin, and consequently these tumors should be divided into two groups: Epithelioma arising from nevi and pavement epithelial carcinoma. He thinks the former is much the more common.

On the other hand, Fuchs says that if nevi at the limbus begin to grow and develop into malignant tumors, it is

always a sarcoma that forms from them and not an epithelioma. This author also says, to which the present writer with a limited experience agrees, that it is impossible to make a radical removal of an epibulbar epithelioma or sarcoma, and for this reason enucleation or even evisceration should be done as early as possible.

De Schweinitz and Shumway, before this Society in 1913, reported the history of a case of epibulbar carcinoma which was somewhat similar to the first case-history cited by the writer. Enucleation was first performed, followed later by evisceration. After eight months there had been no return.

A review of the literature on the subject has been given by these authors, and the writer refers any one to the same for a more extended bibliography. As far as possible the writer has looked still further into the literature and has found the report of a few additional cases.

However, the two reported in the paper, one for eleven years and the other six years, have been observed for a longer period as cured than any other similar cases which the writer has been able to find in the literature at his disposal.

There is some diversity of opinion among authors as to the proper surgical procedure after a diagnosis has been made of these carcinomatous growths. The therapeutic value of *x*-ray and radium, when the growth has involved the eyeball itself, is certainly not encouraging.

However, the writer now has under observation a case of sarcoma in the upper lid and in the orbital cavity, where he has removed the growth five times. In the last two operations 50 mg. of radium was placed in the wound for four hours, after which it was closed with silk sutures. Radium has since been used externally at various intervals, and so far there has been no return of the growth. The first operation was performed six years ago.

On the other hand, the early excision of the growth with an endeavor to preserve the eye has not been followed with

any marked success. The immediate enucleation of the eye or even evisceration of the orbit, if there is extensive involvement of the conjunctiva, offers the surest result for the complete eradication of the growth.

DISCUSSION OF PAPERS OF DRS. CHARLES, HANSELL AND ROY.

Dr. R. S. Lamb, Washington: I concur with Dr. Roy in his conclusions as to the time of doing this work in a radical fashion. Conservative surgery must, at times, be radical. Prior to seven years ago I cut first, and then used the *x*-ray. Since then I have used the *x*-ray a short time before the operation. Sometimes I employ it to relieve the excruciating pain, and then operate within twenty-four hours. I have used the *x*-ray prior to operation, also, to close the lymphatics and prevent the tumor from spreading by metastasis. At the time of the operation, stopping the ether long enough to do the work, I have taken the cautery knife and separated the tumor, during exenteration, from the healthy tissue. This helps to keep the growth and the healthy tissue apart, with the aid of retractors. Other than these, the cautery knife has been the only instrument used in 15 to 20 cases, and in seven years I have had no recurrences or deaths. The tumors have been gliomas, sarcomas, melanosarcomas, and epitheliomas. All have had microscopic examination, and there was no question about the diagnosis.

In cases of glioma seen before extension has not gone beyond the globe and is not anterior to the equator I find that enucleation with section one-half or three-fourths of an inch behind the nerve entrance, and then taking the nerve up with a pair of forceps and cauterizing the area around the sheath, is sufficient.

Three weeks after the first *x*-ray, which is given several days before operation, another *x*-ray treatment is given, and this is continued for six months, every three weeks. After that the treatments are given at intervals of six weeks.

Dr. Clarence A. Veasey, Spokane: In connection with Dr. Roy's paper I desire to exhibit two photographs of a case of primary epithelioma of the conjunctiva which I have recently operated upon.

The patient was a sturdy rancher, apparently otherwise in excellent health, aged fifty-six years. Many years before he had observed a small pigmented spot on the sclera of the affected eye, to the temporal side of the cornea. For two or three years it had been increasing rapidly in size, and at the time he came under my care the growth was so large that the anterior segment of the eyeball was completely covered, and the eyelids were so widely separated that they remained permanently everted. The growth itself was roughened and covered by a crust, evidently from ulceration and exposure. I began my operation with the intention of eviscerating the orbit, but finding so much of the conjunctiva apparently uninvolved, an enucleation was performed, with the removal of as much of the ocular conjunctiva as seemed affected.

A very curious feature of this case was that, although the patient lived within a few hours' travel of many ophthalmic surgeons, he assured me that he had never consulted any one regarding his eye until he came to see me, at which time the growth had attained the size and condition manifested in the photographs. It is my intention to make a full report of this case at some future time.

Dr. C. H. May, New York: I think it would be of interest to report a case similar to that of Dr. Charles, in which there was a decided focal reaction in a patient who had a tumor that resulted badly later on. That child, three years of age, was admitted to the hospital, and a small dose of tuberculin was given, which caused a violent reaction. The dose was exceedingly small, as it is well known that children react very easily to tuberculin. The child's eye presented the following characteristics: A dirty, yellowish exudate covered the pupillary space and the iris; no details of the interior of the eye; tension, normal or diminished. The child's physique gave one the impression of tuberculosis, and this diagnosis was confirmed by a diagnostic tuberculin injection. It was supposed to be a case of tuberculosis, and tuberculin was used in increasing doses for two or three months; and the result was exceedingly good. The exudate cleared up; the details of the iris became visible; the pupil could be seen. There were, at times, violent reactions to the tuberculin; and these were ascribed to the fact that children are suscep-

tible to tuberculin. I once read a paper concerning the injection of tuberculin in a child, in which the writer expressed surprise that there had been a fatal issue; a man with experience in its use would have been surprised if there had not been. This child improved for three months; and there was no question in the minds of the men watching the case but that it was one of tuberculosis. At the end of three months there was a violent reaction, which was attributed to the possibility that one of the interns had made a mistake in the amount injected. Following this there was increase of tension. The eye became red and sore, and it was concluded that since there was probably no sight, it would be better to enucleate the eyeball. At operation it was found to be a case of glioma, and the growth had extended beyond the optic nerve. In that case the positive reaction presented to tuberculin misled me and prevented me from doing an enucleation, which might have saved the child's life.

Dr. C. F. Clark, Columbus, Ohio: The early recognition of the exact character of an intraocular tumor, of course, is of the utmost importance, and I was greatly impressed with the philosophic handling of the subject by Dr. Hansell. On one point I am not clear, however. It is this: I think that he said that early enucleation does not prevent metastasis. I should like to know whether he really means that. I have under observation a case in which the eye was removed. It was a distinct case of melanosarcoma which, I think, will illustrate my point clearly. The patient has been under my observation for a long time. We used radium with very little final effect, and I removed the eye as soon as I felt sure that I was dealing with a serious growth, and probably a sarcoma, but I was not positive until the patient came to me, a few weeks ago, with beginning enlargement of the eyeball of which there had been no indication a few weeks before. I immediately enucleated the eye. The patient is a young lady otherwise apparently in good health, but there is no hope for her, if Dr. Hansell's statement is correct.

I have also several specimens of eyes with sarcoma of the choroid, removed after they had attained the size of half a marble, and I have seen the patients six or seven years afterward with no evidence of metastasis. I think that Dr.

Hansell implied that if metastasis is to occur it will come whether we enucleate early or later. If that is so, we are still in the dark as to what course to pursue.

Dr. Hiram Woods, Baltimore: There are two points in Dr. Hansell's paper to which I should like to draw attention. One concerns the value of transillumination. Some time ago I saw a child, about five years of age, who presented what was clinically a glioma of the retina. There was no history of former inflammation—no clinical evidence of uveitis. Transillumination was taken in a dark room, and the only other observer was the resident physician. He or I may have made a mistake, but when we reached the area of the growth, (it was well forward, and there was no possible reason why we should not see it correctly), everything became dark in the pupil; and yet, when the eye was enucleated, the supposed glioma proved to be nothing but an inflammatory mass. The eye might have been retained. The mass had been due to a former inflammatory trouble, which was not brought out in the history.

As to metastasis, my experience is very limited, but I think that it is more frequent than Dr. Hansell has indicated. I want to put all these things together, and ask for an expression of opinion on this general question: Given an eye in which transillumination is lost, and in which there are definite evidences of a sarcoma, but in which vision is preserved, should we use radium, Roentgen rays, or anything else in the place of enucleation? Dr. Harlan will recall a man who made the rounds in Baltimore, and every one gave the same opinion. He had a growth that caused loss of transillumination, but vision equaled 20/50. This is a primary question, but it involves grave responsibility.

Dr. George F. Fiske, Chicago: Some years ago I published a series of cases of tumors in the bulb which were all melanosarcomata. Seven out of 14 never recurred. The recurrence, when it did take place, was always a year after the operation. I believe in early enucleation, and that this is the only thing to be done.

Dr. C. D. Wescott, Chicago: If I understood Dr. Han-

sell correctly, he said that he had not seen a metastasis. I want to congratulate him, because my experience has been so sad by comparison. I have seen metastases that manifested themselves anywhere from a few months to seven years after operation, and demonstrated by postmortem. I have reported before this Society some cases of flat sarcoma in which the specimens showed that tumor cells may pass through the vascular channels entering the globe, and that we may have involvement of the extraocular tissues when the intraocular tumor is comparatively small. It has been my practice, as soon as I could satisfy myself that I had a malignant tumor in the eye, eliminating other things by the best means of diagnosis at command, to advise enucleation immediately; and if this was not consented to, to abandon the case. I have heard from a patient living fifteen years after the removal of a globe which contained a circumscribed, almost semiglobular, sarcoma, as demonstrated by careful examination. So far as my knowledge goes, that is the only patient who has survived for that length of time in my experience of over thirty years.

Dr. Lamb: What was the location of that tumor?

Dr. Wescott: Almost at the equator of the globe; but whether it extended from there out, up or down, I do not recall. It did not include the ciliary region. It was back of the ciliary body.

Dr. Edward B. Heckel, Pittsburgh: In connection with malignant epibulbar growths, experience has taught me that it is best not to operate, but to remove the tumors by means of the *x*-rays. Their application has been accompanied by some difficulties on account of the length of exposure and the danger of burning and producing necrosis of the cornea. Some years ago it occurred to me to make these exposures under constant irrigation with normal salt solution, and I reported this procedure in a case in 1915, in which the cornea escaped and the eye was not injured in the slightest degree. The result was absolutely perfect and the cure permanent, and remained so for five years, when the patient died from other causes.

Dr. Allen Greenwood, Boston: Dr. Wescott's recom-

mendation of early removal of these tumors justifies Dr. Knapp's enucleation of the eye in the case that he said gave all the appearances of a sarcoma of the choroid. My experience has been a rather sad one. I recall two cases in which the eye with sarcoma was removed in the primary stage of the growth, and in both the tumor, on examination, was found to be of very small size and situated in the equator. In one it was only a little larger than a small bean. Both patients were men. One, after five years, died of sarcoma of the liver, and the other died of the same complication after four years. With that experience I cannot help feeling that the sooner sarcoma of the choroid is removed the better for the patient; and, no matter how early it is removed, there is the possibility of metastasis in the liver.

Dr. J. W. Charles, St. Louis: I am sorry that no one said anything about Coley's fluid. In St. Louis our surgeons feel that they have had some distinct successes with it, and I cannot help feeling that, in these days of *x*-ray and radium treatment, perhaps Coley's fluid has been neglected to some extent in sarcomata. When neither operation nor radium nor the *x*-ray will prevent recurrences, Coley's fluid will perhaps do some good, and I would strongly advise that it be tried. In that connection Dr. McAmis wrote me that he had a boy of nine years who had had the orbit cleaned out, and apparently the entire growth removed. He had had a recurrence, however, and was put on Coley's fluid and, five years later, was well. Another case of nasopharyngeal sarcoma Dr. McAmis also saw; it had recurred after being operated on twice. He suggested Coley's fluid, and when seen some months later, the patient had remained well.

Speaking of positive focal tuberculin reactions in sarcomata, it occurred to me that this might happen without the patient's having tuberculosis. I had never heard of it, and have found nothing in the literature about it, but Dr. Dunn, of Asheville, told me yesterday that he had seen a report by some one in Leipzig who had seen positive tuberculin reactions in sarcoma.

Dr. Howard F. Hansell, Philadelphia: With reference to the statement of Dr. Woods concerning transillumination,

I would say that I am quite in accord with him, and believe that the explanation of the mistakes made —and I believe that they are often made when one depends too much on transillumination— is that they are sometimes due to the absence of pigment. The shadow is more likely to be cast when there is much pigment.

Dr. Clark was correct in saying that I made the statement that early enucleation may not prevent metastasis. I looked up the authorities, though I have not quoted any in my paper, and I found that they agree that 40 to 50 per cent. of tumors of the eyeball are metastatic, and that they quite agree that early enucleation will not prevent metastasis. It appears to me to be analogous to cases of syphilis in which early excision of the primary sore will not prevent the general infection. These cases of tumor, however early discovered, must have existed long enough to permit of entrance of the germs, or whatever it may be that produces the growth, into the general system. I agree with all the speakers that early enucleation should be done for fear metastasis may supervene and to prevent extension to the orbit.

Dr. Dunbar Roy, Atlanta, Ga.: While two or three cases are by no means a criterion on which to base a prognosis, I am convinced in my own mind that when epibulbar epithelioma exists, and the diagnosis has been made clinically and microscopically, the best thing to do is to enucleate the eye, and then exenterate the orbit in case the conjunctiva left is involved. I am convinced that you cannot remove radically an epibulbar epithelioma and have it stand a chance of remaining cured without extension. Of course, it is best to try simple enucleation, first removing as much of the conjunctiva as possible, and if this fails, exenteration.

Regarding the electrocautery mentioned by Dr. Lamb, I wish to mention a case of epithelioma of the pharynx in which I used the galvanocautery, and entirely eradicated the growth. There has been no return. I am satisfied that where you can reach the growth, the electrocautery is one of the best instruments to be used. From a recent experience I have had regarding sarcoma of the nasopharynx, and from reports in the literature, I have used Coley's fluid in a number of cases, and have never found the slightest sign of improvement.

REPORT OF THREE ADDITIONAL CASES OF PARALYSIS OF ACCOMMODATION DUE TO FOCAL INFECTIONS.

CLARENCE A. VEASEY, M.D.,
Spokane, Wash.

At the meeting of the Pacific Coast Oto-Ophthalmological Society in June, 1916, I presented a paper on "Chronic Infections of the Faucial Tonsils as a Causative Factor in the Production of Paralysis of the Accommodation, with the Report of Two Cases."

One of these cases was treated for some time for the paralysis of accommodation without result, and within four days after the removal of the infected tonsils the patient was able to read Jaeger 3, and within six days from the time of the operation the accommodation was entirely restored.

The second case was given no treatment for the ophthalmoplegia, and within three days after the removal of his infected tonsils the accommodation was entirely restored.

In the same paper another case of paralysis of accommodation due to a focal infection is referred to as having occurred in the practice of Dr. T. B. Holloway, of Philadelphia, who was kind enough to give me the notes, the latter case being due to a streptococcic catgut infection.

Since the above report was presented, a number of other similar reports have appeared in the literature, not only from chronic infection of the faucial tonsils, but from focal infection occurring elsewhere, and I wish now to present briefly a report of three additional cases.

Case I.—Miss Blank, aged twenty-one, known by the writer all her life, while on shipboard returning from a three

months' sojourn in the Hawaiian Islands, complained of difficulty in reading fine print. But little attention was paid to the complaint at the time and the condition gradually progressed.

The patient's general health was excellent. There had never been any trouble with the eyes before. She had a very moderate astigmatism, using in O.D. cyl.+.25D. ax. 90°, and in O.S. cyl.+.37D. ax. 90°. The vision of each eye at the time of refraction, two years before, was 6/5+, both with and without lenses.

After reaching home the patient's eyes were examined and she was found to have 6/5 vision in each eye, both with and without glasses, and there was found to be an almost complete paralysis of accommodation. The eye-grounds were normal.

About nine months before the patient had had an infection of the right antrum which cleared up under a few irrigations. Examination at the time of studying the eyes showed no infection of the accessory nasal sinuses, no pus in the nares, and no pus could be expressed from either of the faucial tonsils. A skiagraph of the teeth showed slight absorption at the root of one of the central incisors, a tooth which had been filled, but the filling did not extend to the bottom of the pulp cavity. This tooth was opened and drained, and within two weeks the accommodation had entirely returned.

CASE II.—Miss B. M., aged about thirty, a graduate nurse holding a responsible position in a large hospital, first observed, forty-eight hours before being seen by me, that she could not read ordinary print with the right eye. At the time of the examination the vision was for O.D. 6/30, and for O.S. 6/6. In the right eye the pupil was widely dilated and immobile. There was complete paralysis of accommodation. No gross fundus changes were visible.

In the left eye the pupil was 4 mm. in diameter, normal in reaction, and she could read Jaeger 1 p.p. 7 inches.

An examination of the nasal accessory sinuses was negative. All of them transilluminated well, and there was no free pus in the nose. Large quantities of pus could be expressed from each faucial tonsil, the latter being cryptic

in character. The blood Wassermann and urine were negative. The patient stated that she had formerly had an attack of appendicitis, the appendix not having been removed, but an examination by her surgeon resulted in the report that there was no trouble at the present time, and it was not believed that any focal infection could have arisen from this portion of the body. An examination of the teeth also was negative.

With the belief that the chronic infected tonsils might possibly be the cause of the paralysis of accommodation, they were removed under local anesthesia. Three days later the accommodation was returning, the pupil was much smaller, and the patient could read large print on a magazine cover. Inasmuch as she was in bed at the hospital, no actual measurements of the accommodation were made at this time. Five days after the operation the patient read easily Jaeger 6. One week after the operation the accommodation had entirely returned and Jaeger 1 was easily read, both pupils being equal in size and normal in reaction.

CASE III.—E. B. T., female, married, aged twenty-eight years, was first seen January 31, 1919. She presented a history of great difficulty in reading from time to time, although, according to her statement, her distant vision was fairly good. There was also a history of hemicrania and some complaint of gastro-intestinal disturbance.

The vision for the right eye equaled 6/6, and the patient at the time of the examination read with great difficulty Jaeger 1 p.p. 14 inches. The vision of the left eye was 6/7.5, the patient reading Jaeger 3 p.p. 15 inches with great difficulty.

Examination of the nose and throat showed marked deflection of the nasal septum, but no pressure was present and no free pus; there were chronic diseased tonsils and a large ragged adenoid filled with crypts.

Further tests showed that the patient had an impaired accommodation, and the immediate removal of the tonsils and adenoids was advised. It was not believed by the patient, however, or the patient's husband that the tonsils and adenoids could have anything whatever to do with the ocular condition, and their removal was therefore postponed

until some months later, the eyes continuing in the same condition in the meantime. Within two weeks after the removal of the tonsils and adenoids the patient was again examined, and the vision for O.D. was 6/6, the patient reading easily Jaeger 1 p.p. 9 inches, and for O.S. 6/5, reading easily Jaeger 1 p.p. 7 inches. The general health was also very greatly improved.

This last case was not, at the time that she first came under observation, one of complete paralysis of accommodation, but one of paresis. It is understood that at times the accommodation had been completely paralyzed, and the fact that the condition cleared up so rapidly after the removal of the tonsils seems to place it in the same class with the other two cases.

It is believed that in each instance the paralysis or paresis of accommodation was due to a focal infection, in the first case the absorption at the root of the central incisor giving rise to the focus, and in the second and third cases the focus being found in the chronic diseased tonsils.

DISCUSSION.

DR. H. F. HANSELL, Philadelphia: I was interested, as we all are being interested, in the many reports that have been made during the last few years of the remarkable effects of focal infection. I have had an experience during the last six months that may be received with a certain amount of incredulity, and if it is my feelings will not be hurt. A young man of thirty came to see me on account of not seeing well, and all that I was able to find wrong was myopia of a diopter and a half. Dr. Fielding O. Lewis removed the diseased tonsils, and during the next six months the myopia disappeared. V.=6/6, made worse by any lens.

DR. ALEXANDER DUANE, New York: It has appeared to me that not only a simple paralysis or paresis of accommodation, but also the much more frequent condition of weakness of accommodation and accommodative asthenopia, must be frequently due to these focal infections. For a

number of years, when I got a case of subnormal accommodation. I insisted on the nose being examined, because it has been my experience that accommodative weakness is often dependent on conditions of pressure within the nose without, perhaps, there being any actual sinus infection at all. Indeed, it has been surprising to see the effect that removal of such pressure would produce on the accommodative state. It is only more recently that my attention has been called to other focal infections, particularly those arising from the tonsils and teeth. I may mention one very striking case of the sort, in which accommodative asthenopia occurred. The patient was a naval officer whose refraction and motility had been gone over very carefully, and everything done in the way of their correction. He had all sorts of tests made at the naval hospital without result, and went to the various specialists of New York without benefit. The asthenopia continued, and he could not read at all. He was put on duty at the Bath Iron Works, in connection with naval construction. While there he went to Boston and, remembering that I had said that he should have a most thorough examination, he went to a specialist and had his teeth examined. Incidentally, a tonsillar infection was found. The tonsils were removed, and almost immediately his asthenopia disappeared. That is one of the most striking cases, but it has been paralleled by others not so remarkable.

DR. LUCIEN HOWE, Buffalo: If some infections can cause paralysis of accommodation, there is no reason apparently why others may not produce a spasm of accommodation sufficient to account for the clinical appearances.

DR. T. B. HOLLOWAY, Philadelphia: Dr. Veasey was good enough to refer to the case notes that I sent him three or four years ago. It is hardly fair to include this case as strictly one of focal infection. The patient was admitted to the hospital for a series of operations. He developed a violent streptococcic catgut infection, so exceptions could well be taken to including this as one of focal infection. When he came under my observation he had a paresis of accommodation. It was the first time that I had seen one of such a character, and I have been watching for similar cases since that time. In discussing this case with Dr. Apple, of Lan-

caster, he said that a case of throat infection had come under his observation in which repeated cultures had shown nothing but the streptococcus. He sent the patient to me, and I found that she had a paresis of accommodation. This case would also come under suspicion because she had other paralyses, which are recognized as frequently accompanying a diphtheritic infection.

In testing the accommodation of what are apparently true cases of involvement of accommodation, as well as cases of supposed hysteria or malingering, I have found that it is of great service to measure the near point with a series of lenses instead of with possibly one lens. At the next visit no regular order is used in placing these lenses before the eye. This method has been of service to me on more than one occasion in distinguishing between a true paralytic and a functional condition. Doubtless many members of the Society may resort to the same test, but I do not recall having seen it mentioned.

DR. HIRAM WOODS, Baltimore: Dr. Hansell's case suggests another form of possible focal irritation. The cases of Dr. Veasey are paralytic; the case of Dr. Hansell seems to be one of dynamic myopia produced by some irritation, and the disappearance of it after the discovery of the focal irritation points pretty clearly to the cause. Some years ago Dr. Theobald, in a personal conversation, called my attention to another form of this trouble. We were speaking of the class of cases in which there is a tremendous difficulty in getting satisfactory cycloplegia. You begin with homatropin, and do not get anywhere; that is, in the subjective examination. The axis of a low grade of astigmatism, for instance, will vary from 65° to 110°; and the longer you keep the patient under examination, the more uncertain he gets and the more annoyed you get. Then you wait, and go on with your cycloplegia, using atropin or hyoscyamin; and it is several days before you can get anything like a satisfactory agreement between objective measurement and subjective tests. Dr. Theobald asked whether I had looked at the child's teeth. There were two or three teeth that needed attention; one was extracted. Since then I have found, or thought that I have found, an explanation for this

very troublesome class of cases—cases in which the ciliary muscle will not relax promptly and definitely. I have seen it associated most frequently with dental irritation, but I believe that it can come from other forms of focal irritation, and it is simply a different class of irritation. One is an irritative one, and the other paretic, or at least inhibitory.

DR. J. P. WORRELL, Terre Haute, Ind.: Some years ago a young man, twenty-eight years of age, of excellent personal and family history, consulted me on account of an iridocyclitis of the right eye following an injury received one year previously. Removal was indicated. In order to obtain as good cosmetic effect as possible an evisceration was done instead of an enucleation. The operation was followed by little reaction. In a few weeks an artificial eye was inserted which he wore with great satisfaction. A few weeks ago he appeared complaining of mistiness of distant vision and inability to read at ordinary reading distance. V.=20 20, with sph.+0.25=20 16. Near point, 11 inches, with sph. +2, but rapidly receding. Under cycloplegia the total error was sph.+0.50.

In view of the fact that paralysis of the accommodation is mentioned as one of the results of sympathetic irritation, the possible responsibility of the stump of the right eye for this trouble in this instance naturally came to my mind. However, to the suggestion that the stump be removed, the patient demurred until all efforts were exhausted to locate the responsibility for the paralysis in some other organ. In search for this cause the nose and sinuses, tonsils, and teeth were carefully investigated with negative results, with the exception of two defective teeth which were extracted. Three weeks were allowed to elapse when, there being no improvement, the alleged offending stump was removed. No adhesions existed. The conjunctiva adherent to the site of the former incision was readily raised, Tenon's capsule opened, and the remains of the eyeball removed without difficulty. Section of the removed stump presented thickened convoluted sclera. Just before leaving home to attend this meeting, three weeks after the operation, the patient reported that he was better. V., refraction uncorrected, =20/16, with sph.+2 the nearest reading distance con-

tinued to be 11 inches, although he could read longer without being obliged to move the text further away.

Since making the above report, and eight weeks after the operation, V.=20 16. Plus glass declined, and near point normal. Recovery appears complete.

DR. GEORGE E. DE SCHWEINITZ, Philadelphia: Disturbances of accommodation the result of toxic influences arising from local septic areas may appear rapidly or be delayed. Thus cases are on record of paresis of accommodation which appear quickly after the ingestion of certain food-stuffs which have created a gastric or intestinal sepsis. In other cases focal infection may have existed for a long time before any of its effects at distant points are evident. This may be explained as follows: If, as Rosenow has maintained, an area of focal infection, for example, a tooth-root abscess, is a depot in which is manufactured diffusible toxins, some of which possess an affinity for certain cells, the special type of toxin may not at first be produced. We speak of the physiologic action of drugs, or, as Dr. H. C. Wood once said, the histologic action of drugs; one drug affects, for example, the peripheral ends of the pneumogastric in the heart, another the cortical cells of the brain, etc. Is it not possible that from focal infections various diffusible toxins, if that vague term is permitted, arise, one having a selective affinity for one set of cells, another for a different set of cells, and a third which fails to reach the tissue or cells for which it has an affinity? Hence sometimes the effect is prompt, sometimes delayed, and sometimes, even though the septic area has long existed, no deleterious result at some distant point becomes evident. This is, of course, largely speculative, but may explain some of the phenomena at present in discussion.

ACCOMMODATION IN THE LENSLESS EYE OCCURRING IN A WOMAN AGED SEVENTY-THREE YEARS, FOLLOWING EXTRACTION OF CATARACT.

A. EDWARD DAVIS, A.M., M.D.,
New York.

In 1895* the author reported two cases of accommodation in the lensless eye, one in a young subject, the other in a man forty-two years of age, both following extraction of cataract, together with a review of the literature on the subject up to that date.

Having observed another even more remarkable case of the same nature, occurring in a woman seventy-three years of age, I have thought it worth while to report the case before this scientific body, and to have an expression of opinion on the question, to wit, whether the lensless eye has accommodation power.

Förster, Woinow, von Graefe, Silex, Jaeger, Loring, the author, and many others maintain that accommodative power, in exceptional cases, is present in the lensless eye; while such eminent authorities as Helmholtz, Donders, Manhardt, etc., oppose this contention, Donders declaring that his investigations had convinced him "that in aphakia not the slightest trace of accommodative power remains," and says further.† "In old people, and with imperfect acuteness of vision, observers sometimes think they are able to prove the existence of a certain amount of range of accommodation; but in young persons, with perfectly clear pupils

* Manhattan Eye and Ear Hospital Reports, January, 1895.

† Donders: Accommodation and Refraction of the Eye, p. 320.

and great acuteness of vision, in whom precisely we might still expect to find some accommodative power, it is quite evident that the latter is entirely lost." Donders then reports two cases in young people in whom the lens had been removed by discission, with excellent result, the vision being extraordinarily acute in one case, in which no trace of accommodative power could be demonstrated. His method of testing the accommodative power was the familiar one of looking at a point of light in the distance with the refractive error properly corrected. "With glasses of 1 3, placed 5′′′ from the eye, he saw, at a great distance, a point of light sufficiently round and perfectly defined. A sight vizier was placed in the direction between one of the eyes and the point of light, and when he looked with converging visual lines toward the sight, the point of light remained unchanged or became somewhat smaller and sharper, without changing its form. If the lens was removed only 1/4′′′ more or less from the eye, the distant point of light had ceased to be a defined, round point, and was elongated in one direction, to the form of a line; now even with the most powerful exertion and convergence in the point of the sight the line of light became only somewhat shorter without, however, a point making its appearance. This shortening, as well as the diminution of the acutely seen point, depended upon narrowing of the pupil which was, indeed, directly observed."

In a second case a similar test was made with a like result, and an additional test was made, to wit: While the patient was looking at the point of light with his correction on he interposed a weak plus (1 180) or minus glass (1 180) in front of the eye, which produced the well-known change in the point of light: the patient constantly stated that "by + 1 180 (.25 D.) the point of light was extended in the vertical, by − 1 180 (.25 D.) in the horizontal direction to a short line. On the other hand, the convergence of the visual lines, with the effort to see near objects, was not followed by the slightest

change of form, consequently there was no reason to suppose the existence of accommodative power."* The same experiment was repeated with a lens of only 1 300 (about .12 D.) with similar results, consequently Donders concluded that not a trace of accommodative power was left in the lensless eye, even in young subjects.

I have given both of Donders' tests† rather fully, in order to show the error made in the first and the unreliability of the second. In the first, he states that he moved the correcting glass 1 3 (or +12 D.) slightly (1 4''') *from* the eye, then had the patient make accommodative efforts to correct the blurred image, which had been brought about by moving the glass *forward*. I submit that the correcting glass should have been moved *toward* the eye (backward) if the accommodative effort was to be tested. In regard to the second test of interposing a very weak glass (plus or minus) in front of the correcting glass, and noting if the image is elongated in the vertical meridian by a plus glass, or in the horizontal meridian by a minus glass, is often most contradictory and unsatisfactory. In other words, I do not think Donders made sufficient tests to prove his contention that no trace of accommodative power remains in the lensless eye.

It is interesting to cite here the case reported by Loring of an exactly similar type as the two reported by Donders, in which Loring arrives at diametrically opposite conclusions to those found by Donders. The patient was a young girl aged eighteen years, in whom both lenses had been removed by discission: "The pupils were round, free from membrane and active. With +1 13.5 the patient read with either eye easily Snellen XXX, and was able, with both eyes, to pick out most of the letters of XX at 20 feet. She could read X at 10 feet, and V at 5 feet. With the same

* *Loc. cit.*, p. 321.

† Donders did not give the result of his tests with Snellen or Jaeger types, but used only a point of light.

glass, and with no change of position on the nose, she read No. 1½ Snellen fluently, holding the book naturally at 12 inches, which was about the same distance at which she usually read. The book was then gradually withdrawn, the patient reading aloud while this was done. It was found that 21½ inches was the greatest distance at which No. 1½ Snellen could be read. She read No. 1 Jaeger at 20 inches. The book was then advanced inch by inch, the patient reading aloud till the book was within five inches of the eye. Inside of this, reading was impossible. These experiments were tried over and over again by myself, and were finally repeated in the presence of a brother oculist. This would give the patient an adaptability of the eyes for different distances from 20 feet (or parallel rays) to 5 inches; or, in other words, an accommodation of 1 5 (A = 1 5) and a relative accommodation for the very finest print from 20 inches to 5 (A = 1/6½)."

One could not ask for more convincing proof of accommodation in the lensless eye than the report of the above case of Loring's. However, one of the cases reported by myself, already referred to, is just as convincing.* Very briefly stated, the salient points in the case are: A man forty-two years of age had combined extraction of a black cataract in the right eye January 17, 1894. Three months after the extraction V. = Snellen 20 10 with +11.50 D., and with the same glass, which he did not move on his nose, he read Jaeger No. 1 from 14 inches to 18 inches. On February 4, 1895, the patient maintained his marked acuteness of 20 10 with +11.50 D., and read Jaeger No. 1 from 8 to 22½ inches. The shape of the pupil in this case was an irregular vertical oval from the iridectomy, and free from membrane, except a very narrow margin at the edge. The transverse diameter was 3½ mm., the vertical about 7 mm. This

* For full report of this case see Manhattan Eye and Ear Hospital Reports, January, 1895.

patient was presented before the New York Ophthalmological Society in October, 1894, but the members were divided in their opinions as to how the patient was able to accommodate for the near point.

REPORT OF PRESENT CASE.—Mrs. J. H. B., aged seventy-three years, in fairly good health, consulted me January 18, 1919. Senile cataract in each eye, mature in the left; R.V. = fingers 4 feet; L.V. = LP., projection good.

February 7th, under cocain anesthesia, a combined extraction was performed on the left eye. There was an uninterrupted recovery, and the patient was discharged from the hospital on the seventh day. March 22d, six weeks after the operation, she was tested for glasses with the following result:

Ophthalmometer: Astigmatism against the rule, 2.50 D., 150+, 60−. V.L.E. = 15/30 with sph. +16.00 ⊃ cyl. +1.50 ax. 150°. The patient reads Jaeger No. 1, 7 inches to 13 inches, with the same glass without changing position of the glasses or tilting same. By preference she holds ordinary newspaper print at 8 inches. The ophthalmoscope shows H .16 D. and the media clear. The pupil is closed by a membrane, except for a clear space at the center, vertically oval in shape, 2½ by 3½ mm. in diameter.

The patient, when she came under my care, was wearing O.D. sph. +6.00 ⊃ cyl. +2.00 ax. 60°; O.S. sph. +6.00 ⊃ cyl. +2.00 ax. 135°. She gave a history of having strabismus in childhood, which "was cured by having the ears pierced."* However, it is significant that the patient later in childhood wore strong convex glasses, which likely accounts for the cure of the squint without operation.

Extensive and rigid tests were made in the two former cases reported by me, and the same were repeated in the

* The following letter concerning this case was received by me from Dr. T. H. Farrell, of Utica, N. Y.:

Dear Dr. Davis: In answer to your letter of the 5th inst. regarding Mrs. J. H. Browning, I find that I examined her eyes on March 27, 1915. At that time her vision was O.D. 20/100, with sph. +6.00 ⊃ cyl. +2.00 ax. 60. O.S. 20/100, with sph. +6.00 ⊃ cyl. +2.00 ax. 135. The centers of both lenses were sclerosed. Another peculiarity about this case is that when a child she had squint, which was cured by piercing her ears.

present case. Subjective tests: 1. (*a*) Acuteness of vision for distance and near point, with the distance glasses; (*b*) same with upper lid held up; (*c*) same with a few drops of cocain instilled and speculum to hold lids open; (*d*) adding weak plus or minus glasses to distance glasses and noting changes in acuteness of vision; (*e*) to repeat the above tests with the opposing eye uncovered and with the visual lines converging. 2. Testing the acuteness of vision for a distant point of light (after Donders' method), under the five conditions imposed in test No. 1.

Objective tests: 1. (*a*) Measurement, with the ophthalmometer, of the radius of curvature of the two chief meridians of the cornea at the point where the visual line intersects same; (*b*) the same measurement five degrees to the temporal side of this point, which is close to the apex of the cornea, as the angle alpha is usually positive and about five degrees in amount. 2. (*a*) With the Placido disc removed from the cylinder of the ophthalmometer, and with the patient looking five degrees to the inner or nasal side, to note if any changes are made in the relative position and size of the corneal images when the eye changes from looking in the distance to a near point, *the eye not changing its direction;* (*b*) the same test with lids held open with a speculum; (*c*) with the opposite eye uncovered, both of the above tests repeated. 3. Ophthalmoscopic measurements of the fundus were made to see if any change in depth occurred when the eye changed from a state of rest to accommodative efforts. 4. The size and shape of the pupil, if clear, or partially filled with membrane, activity, etc., noted. All of the above tests were carefully made in the present case, with the visual results noted in the case report, that is, vision, 15/30 with sph. +16.00 ⊃ cyl. +1.50 ax. 150°, and with the same glass, without being moved or tilted in any way, she read with ease, and was a matter of choice, Jaeger No. 1 at 7 inches, and after atropin had been instilled three times a day for

three days Jaeger No. 1 could still be read from 8 inches to 13 inches, the near point having receded from the eye one inch under the influence of the cycloplegic.* This would indicate that, in this patient at least, the ciliary muscle had some influence on the accommodation, even after the lens was removed; for without atropin in the eye the patient could read Jaeger No. 1 at 7 inches, while with atropin in the eye the Jaeger No. 1 could not be read closer than 8 inches. Now the difference between a lens of 7 inches focus (5.71 D.) and one of 8 inches focus (5 D.) is .71 D., that is, the ciliary muscle exercised accommodative effort of .71 D., about three-fourths of a diopter. (When the right eye was covered in these tests, it was seen to turn in, and the pupil to contract for the near point.)

Donders' test with a point of light in the distance, where weak plus or minus glasses were interposed in front of the correcting glass, proved unsatisfactory, as the patient made contradictory statements.

As to the objective tests in this case, the ophthalmometer showed an astigmatism of 2.50 D. against the rule, the lesser refracting meridian being at 60°, (40.50 D.), while the stronger refracting meridian was at 150°. (43 D.) in refractive power.

When the patient made accommodative effort when looking into the tube of the instrument (the images of the mires having been approximated just so they touched before the effort was made) the images would overlap about .75 D. in the meridian at 150° and became slightly blurred, and the instrument had to be pulled slightly away from the patient to get a clear image. When this experiment was tried with the meridian at 60°, little or no change in the images of the mires occurred.

It was impossible to detect any change in the depth of the

* These tests were repeated in the presence of a fellow oculist, Dr. F. W. Shine.

fundus of the eye with the ophthalmoscope when the eye changed from a state of rest while looking in the distance and when making accommodative effort. However, that the curve of the cornea can be changed by accommodative effort to a slight extent at least, in the lensless eye, is shown by two of my cases. In the normal eye the change in curvature of the cornea by accommodative effort is in some cases very marked. The most marked case of this kind that I have seen occurred in the person of Dr. C. H. Johnson, a former house-surgeon at the Manhattan Eye and Ear Hospital. The ophthalmometer showed him to have ordinarily an astigmatism of .50 D. ax. 90°+180°−, each eye. He could, however, without in any way changing the direction of the eye, voluntarily, by efforts of accommodation, change this in the right eye to 2 D., and in the left to 1.50 D. He was able to do this while the upper lid was held up with the finger, showing that it was not due to lid-pressure. He did this many times, and the same change was observed by a number of the staff at the hospital. Desiring to know if this change was due to the action of the ciliary muscle or to that of the external muscles of the eye, I wrote to the late Dr. J. M. Ray, of Louisville, where Dr. Johnson resided, to put Dr. Johnson's eyes under the influence of a cycloplegic, and in that way eliminate the question of the ciliary muscle. I give his report:

"V.R.E. 20 20; V.L.E. 20 20. Ophthalmometer shows astigmatism with the rule, .50 D. ax. 70°+160°−Rt.; 90°+180°−Lt. When he made an effort at accommodation without changing the direction of his eye, the astigmatism was seen to go up to 2 D. in the right, and 1.50 D. in the left eye. Scopolamin, four instillations of $\frac{1}{6}$ per cent. solution, apparently paralyzed accommodation. Then with the ophthalmometer the astigmatism still seemed to increase in the right eye to 1.50 D., and in the left to 1 D."

From this it appears that, in Dr. Johnson's case, the change

in the curve of the cornea was brought about mainly by the external muscles of the eye, as the influence of the lids and ciliary muscle was eliminated.

My own conclusion, from studying the history of the subject, and from the careful and complete tests made in the three cases here reported, is that the accommodation present in the lensless eye is due chiefly to the ability of the patient in such cases to interpret dispersion circles. The slight change in curvature of the cornea, and its slight advancement observed in some instances may, in those cases, account for some of the accommodative power, but it is such a small factor that it may be eliminated entirely, especially since in some of the most marked cases of accommodation in aphakial eyes no such changes have been observed. How the change in the curvature of the cornea and its advancement are brought about have been discussed in this paper.

Although, as Loring says, "It would seem impossible that the ability to read the finest print at five inches, which was done in his case, even taking into consideration the magnifying power of the glass, could be due to the overcoming of the circles of dispersion," yet I believe such to be the case, and for the following reasons: First, to the great increase in size of the retinal images by the removal of the crystalline lens and replacing it with a lens in front of the eye. By this procedure the united nodal point is moved forward, and this, with the magnifying power of the glass in front of the eye, greatly increases in size the retinal images. Donders* has shown by calculation that a convex lens of three-inch focus, placed one-half inch, the usual distance, in front of the eye increases the retinal images in size one and one-third times. By this one factor alone the images of Jaeger No. 1 would be increased in size until they equaled, for the unoperated eye, Jaeger No. 2 or a little larger. Second, to the narrowing of the pupil. Where no iridectomy is done, this

* Accommodation and Refraction of the Eye, p. 318.

is due to contraction of the iris as the result of convergence and an effort at accommodation; where an iridectomy is done, to a partial filling up of the pupil by membrane, except a central opening. It is a well-known fact that if the pupil is narrowed from any cause, such narrowing acts as a diaphragm to cut off the peripheral rays of light entering the eye, and serves in this way to lessen the dispersion circles. Third, to the extraordinary acuteness of vision present sometimes after cataract extractions, *e. g.*, as happened in one of my cases where it was 20/10, double the ordinary acuteness of vision. I believe this fact contributed largely to the power of interpretation present in this case, for he had an iridectomy and a clear pupil. Fourth, in some cases, to the patient not looking directly through the center of the glass, but slightly outside of the center, either by tilting the glasses, tilting his head, or not holding the reading matter directly in front of him. In my opinion this fourth factor, in effect, a slight tilting of the strong plus glasses, assists the individual in interpreting dispersion circles chiefly by neutralizing the monochromatic aberration present in such cases. This is a point which no writer has hitherto called attention to in discussing the subject. William Harkness has shown that, "with a pupil four millimeters in diameter, the normal cornea produces monochromatic aberration to the extent of 1.33: and as there is no confusion of images in the normal eye, it seems probable that the crystalline lens exerts some compensating action. This suspicion is strengthened by the well-known fact that in aphakia the acuteness of vision is nearly always improved by giving a certain inclination to the powerful convex glasses which are then necessary."

DISCUSSION.

DR. C. D. WESCOTT, Chicago: I think that Dr. Davis has said nothing about the condition of the capsule in these cases. I have one case under observation, and have had for many

years, in which both lenses were involved in trauma. Traumatic cataract was finally absorbed by repeated needlings, but a hard, dense capsule remained, in which there was a small vertical, oval opening. This patient required a sph.+ 10 lens with the correction of astigmatism for distant vision, and got 6/9. He could read J. 1 comfortably without any addition. The explanation was, I think, the pinhole pupil. I have 2.5 D. of presbyopia, but with the stenopaic disc I read J. 1. In a case in which I made an extraction for cataract, the patient required sph.+ 10 with cylinder for distant vision. She read with perfect ease without any spheric addition, but in that case the capsule was dense, with a central slit forming a clear opening that appeared to be not more than a millimeter in diameter.

DR. C. F. CLARK, Columbus, Ohio: Owing to lack of time I was not able to report one of the cases that illustrated my paper on dislocation and coloboma of the lens. I would like to show a diagram of that case which illustrates this point very clearly. This is an eye with dislocation of the lens downward, coming on in a patient evidently congenitally affected, but immediately as the result of a slight traumatism. This man, with sph.+ 18 had vision of 5/7 right and 5/6 left, and with the same glass read with entire satisfaction. He has carried on his business for fifteen years with this glass and a slight correction of his corneal astigmatism, and has excellent range of accommodation. I reported this case to our state society, and, as Dr. Risley happened to be present as the guest of our section, we had the benefit of his discussion. The patient whose case I was describing has a very small pupil, and I had attributed his apparent accommodative power to the stenopaic diaphragm, as in pinhole photography, but Dr. Risley reminded me of the fact that, some years ago, the late Dr. John Green, of St. Louis, had worked out carefully the degrees of variation in vision produced by looking obliquely at various angles through a strong convex lens. Dr. Risley described a case of so-called accommodation in an aphakic eye which had been exhibited to the members of one of the ophthalmologic societies at which he was present, and which excited a great deal of interest, the patient being able to see well at distance and read with ease

with the same lens. The doctor, while traveling in the South some time after this exhibition, chanced to meet this patient, who reminded him of the fact that he had been exhibited at the society, and that he possessed this unusual power of accommodation in an eye from which the lens had been removed. Noticing, however, that in reading the print was well down where it was seen obliquely through the strong convex lens, the doctor requested him to hold it up in a line perpendicular to the plane of the lens, and the patient was greatly chagrined to discover that his power of "accommodation" had entirely failed him.

DR. WILLIAM ZENTMAYER, Philadelphia: About a year ago, before the College of Physicians of Philadelphia, I showed a little girl on whom I had operated for cataract. After the first discission a bud of cortex protruded from a small opening in the anterior capsule. The absorption being slow, I later did a linear extraction. With distance glasses she was then and is still able to read J. 1 at any visible distance for this type with perfect facility. I used the case as a basis for reviewing the subject.

I think the statement of Donders that aphakic eyes are totally without the power of accommodation has been misinterpreted. What I believe he meant was that accommodation, in the sense that we usually employ the term, is not present in aphakic eyes it is not accommodation accomplished in the usual way. Schmidt-Rimpler states that with his aphakic eye he had a certain range over which he could read, but at no distance did he see plainly. There are a great many attempted explanations of this phenomenon, and doubtless some of them are correct for individual cases, but it seems to me the explanation of a stenopaic opening is the one that applies to most cases and to my own. This is the opinion of most of those who have studied the matter carefully.

DR. WILLIAM TARUN, Baltimore: I am going to take the opposite view from that of the essayist and say that I strongly believe Donders' theory is correct. The cases reported by Dr. Clark may be left out of consideration, as these were dislocated lenses, and one must assume the presence of accommodation, at least partial. Some years ago I

had the privilege of seeing my first case of a lenseless eye in which the patient could read at ordinary reading distance with the distant correction. The patient, a man fifty-five years of age, operated upon with good visual result, 20/20 corrected. He could read J. 1 with his distant correction without difficulty. The case was such a surprise that my colleague thought he had a case of accommodation in the aphakic eye. Something about the facial expression of the patient attracted my attention, so I said to him, "Open your eyes naturally." He did so; he was then told to read, but was unable to see any print on the hand card.

There are probably several factors present in a condition of this kind. Dr. Davis says that he has tried cases with accommodation paralyzed. The patient I refer to was still under atropin. Some patients who have deficient vision for distance, particularly myopes, can improve this defect by a certain squinting of the lids. All cannot do so. There are presbyopes, of a certain degree who can do the same thing.

The other factor is the presence in the capsule of a small opening comparable to the pinhole opening that we find in the trial disc. You are all familiar with the fact that when you lose your presbyopic correction, if you take a card having a pinhole, by looking through the pinhole your vision will be sufficiently improved to read even the print of a newspaper.

I have since tried these experiments and found nearly all could do the same thing. When told to read they could do so by squinting the lids sufficiently to improve their vision. Those with an opening in the capsule did better than those without. These observations have shown me that Donders' theory of loss of accommodation in the aphakic eye is correct.

DR. J. A. WHITE, Richmond, Va.: I reported a similar case in 1897. The patient, a man forty-five years of age, blind in the right eye with cataract, but had the left lens removed four years previously. With sph.+12⊃cyl.+1.50 axis 180° vision = 20/20 and J. 1. With sph.+11⊃with cylinder vision = 20/15. The curious feature of the case was that with a dilated pupil he required sph.+10⊃cyl.+2.25 axis 180° for 20/15, and sph.+13⊃cyl.+2.25 axis 180° to read. Thus, under the mydriatic he needed a difference of 3 diop-

ters between the distance and reading lenses and an increase in the power of the cylinder. That is, with no lens present, his accommodation was considerably altered by the mydriatic.

Examination showed two openings in the capsule, one of which was covered by the iris when the pupil was contracted. I thought then that the only satisfactory explanation of this so-called accommodation in a lensless eye was the suggestion of Loring, an individual ability to interpret dispersion circles when his pupil was contracted and he looked through only one hole in the capsule. When the pupil was dilated, as there were two holes, and the circles overlapped, they were not so easy to interpret. I could not, however, explain why he required the addition of sph.+3 for reading, and at the same time a sph.+10 instead of sph. +11 D, to see at a distance. The interpretation of dispersion circles might have been as satisfactory an explanation as we have had, but my reliance on this was considerably shaken by two other cases of the same kind. These patients were sisters of this man. The younger sister had a posterior polar cataract, and the older a natural cortical cataract when I first saw her. Both were operated on. Both have the same ability. Both use the same lens for distance and reading. Both read J. 1, and get 20/20. One has an opening in the capsule. The other has a perfectly clear pupillary area, but still has the same ability to accommodate for reading with her distance lens. She can read a newspaper and get 20/20 vision at a distance.

This has changed my mind about the explanation regarding the interpretation of dispersion circles. As these ladies live in the vicinity of our next place of meeting, I will try and induce them to come there and let the members reason out this special family ability.

DR. HERBERT HARLAN, Baltimore: Two or three weeks ago, after reading the abstract of Dr. Davis's paper, it happened that on the following day I found this case in my clinic at the hospital, which I think has enough interest in this connection to deserve reporting. The patient, a young woman aged twenty-five years, had a black pupil on one side, and a dense white one on the other. She stated that eleven

years ago, when she was fourteen years old, she had had the left eye operated on for cataract by a man that I do not know, in a small town in Maryland. She wanted to see whether something could not be done for the non-operated eye. I asked her what she could do with the one operated on, and she said, "It is perfectly good. I can read with it." She had 15 50 without correction. She never had had correction. She remarked that she had read all Mark Twain's books without a glass. Then I began testing, and found 4.5 D. of hyperopia. That improved her vision to 15 30, minus 1. Two days later I tested again, and verified it in every particular. I was unable to improve her vision by another glass. There had been a mydriatic put in, and there were some shreds of capsule present. The pupil was originally about 4 mm. long, and 2 mm. wide at the widest part. The other eye, she said, had never been operated on. The pupil was filled with a dense white membrane. Three days later, when she was lying on the table with the good eye closed, I put in a pair of forceps and pulled out this very tough membrane. She immediately smiled and said, "I see you perfectly—as well as with the other eye." There is no doubt that this girl, with a lensless eye, had 4.5 D. of hyperopia, and could read J. 1 without any glass at 8 inches. I am, naturally, much interested as to the outcome in the other eye. I am hoping that she will have as much accommodation in the left eye as in the right.

DR. DERRICK T. VAIL, Cincinnati: I should like to say something about "accommodation of the lens to the lensless eye." I have a number of patients who wear their full correcting glasses with 20 20 vision, and with the same glasses are able to read ordinary newspaper print readily by taking advantage of the well-known effect produced by pulling the spectacle-frames slightly down their noses.

DR. W. E. LAMBERT, New York: I do not recall a case in adults in which this condition has been observed, but I have frequently observed it in young people in cases of congenital dislocated lenses and in congenital cataracts.

In none of my cases could the explanation of a stenopaic opening explain the ability to read with distance correction. It seems to me that the explanation may be due largely to

the action of the extrinsic ocular muscles in producing a change in the anteroposterior axis of the globe, and possibly in a change in the curvature of the cornea, increasing its convexity.

DR. EDWARD JACKSON, Denver: To bring the discussion back toward Dr. Davis's paper, I want to mention a case that supports his view regarding the interpretation of images. Some years ago I examined a man with about 6 D. of myopia who had the ordinary impairment of vision that goes with myopia, and improvement of vision when I put on glasses. In the course of the examinations it came out that he was quite a rifle shot; that he had made record scores, and had been a valuable member of rifle teams, shooting without any glasses. He could not bring up his vision to anywhere near normal by any manipulation of his lids. But in a strong light, out-of-doors, his pupils contracted decidedly, and he had learned to interpret the target in what most of us would not notice was the target. There was as much light falling on his retina from the target as if the eyes had been perfectly focused. The subject of retinal images with diffusion circles is interesting in this connection. They certainly are capable of much more accurate interpretation than one who had not experienced them through a long period would suppose possible.

Just one other point that we have had referred to this morning: A great many explanations for the ability to read at different distances without accommodation have been mentioned. I think that these cases should be spoken of as the ability to read without accommodation. Accommodation, since the time that Donders brought out his work, has had a definite meaning; and this should not be violated by speaking of this ability to read without accommodation as accommodation in a lensless eye. These cases are not of vision with accommodation, but without accommodation, by means of compensatory devices or tricks.

One of these that has not been mentioned this morning, and which may be of a great deal of importance, is the influence of lid pressure on the cornea. This varies with different patients. The thickness of the cornea varies more than books or ordinary observation would lead us to sup-

pose. I remember one girl with between 2 D. and 3 D. of myopia, and 3 D. of astigmatism, who had found that by putting her finger near the outer canthus and drawing on her lower lid she could get full vision across the room. She had not worn glasses.

DR. A. EDWARD DAVIS, New York: I should like to make one remark regarding the membrane in the pupil in these cases. There was a membrane in each case, but an opening in each at the center. I have given the dimensions of each. It was in one case, 4 x 7 mm., vertical; and in the last case, 2 x 3 or 3½ mm. In one case there was no astigmatism, so it could not be due to the patient's using first one meridian of the cornea and then the other.

Regarding the accommodating of the glass to the patient, Donders made that recommendation in his book many years ago. One other explanation is monochromatic aberration, which is corrected in part by tilting the glass. It nearly always improves the vision by giving the strong glasses necessary after extraction of cataract a slight tilt. I think that this may be one of the points that aids patients to accommodate the eye to a near point after the crystalline lens has been removed.

PERSISTENT POSTERIOR FIBROVASCULAR SHEATH OF THE LENS. A REPORT OF TWO CLINICAL CASES, AND THREE BULBS EXAMINED MICROSCOPICALLY.*

FRANCIS LANE, M.D.,
Chicago.

Clinical observations obtained from two cases of unusual cataract, and the microscopic findings of three bulbs misinterpreted for glioma,† convince me that certain so-called pathologic clinical changes of the lens and anterior vitreous often indicate arrested development.

Collins, in 1892, gave a detailed anatomic description of persistent posterior fibrovascular sheath of the lens in three cases, and since then has recognized a like number of cases clinically; to him, therefore, we are greatly indebted for early valuable suggestions offering a clearer understanding of the existence of certain developmental irregularities.

Embryologists agree that the arteria hyaloidea makes its first appearance at the "greatest length" of 5 mm.; a cuticular deposit surrounds the lens vesicle in very early embryonic life, and the posterior capsule is demonstrable as such at the greatest length of 12.7 mm.; the posterior lens vesicle cells have elongated into lens-fibers at a length of 13—14 mm., and the further development of fibers continues from the equatorial region as in the adult; at the beginning of the second month the arteria hyaloidea extends through the entire optic cup as a blood-carrying vessel, and ends

* Candidate's thesis for membership accepted by the Committee on Theses.

† From the laboratory and clinics of the Illinois Charitable Eye and Ear Infirmary.

anteriorly at the posterior pole of the lens vesicle; in the ninth week the mesodermal capsula perilenticularis goes over into the tunica vasculosa lentis, which at this stage consists only of blood-vessels and surrounds the posterior half of the lens. The circulation of blood in the hyaloid ceases, the artery regresses to a solid strand and disappears simultaneously with the tunica vasculosa lentis respectively during the sixth, seventh, and eighth months.

No satisfactory theory has been advanced to explain either the incomplete formation of the posterior capsule or the failure of the posterior cells of the lens vesicle to elongate into axial fibers. A too rapid development of the antero-posterior diameter of the secondary optic vesicle, or a failure of the elongation of the arteria hyaloidea to keep pace with the normal axial diameter of the cup, or both, might cause sufficient traction on the proverbially thin lens capsule at the region of the posterior pole to cause a laceration and permanent gap by surface expansion.

An intact capsule is impermeable to all substances except fluids. In the absence of a pigment producing intraocular foreign body, pigmentation in the lens substance must be regarded as hematogenous in origin; all the more so may this be expected if a gap of the posterior capsule exists and the hyaloid artery persists.

Furthermore, if the hyaloidea develops to unusual caliber one might conceive how it is possible for the undifferentiated mesoderm of the capsula perilenticularis not to disappear, but to follow the laws of development and to proliferate because of over blood supply, possibly at the expense of lens development, and by so doing favor the persistence of the arteria hyaloidea.

CLINICAL CASE 1.—Joe B., aged fourteen. Dr. Charles Clement permits me to report this case-history, the patient having consulted him because of poor vision and an upward convergent squint of the right eye. The parents did not

notice anything unusual about the eye except the squint. This was first observed when the infant was about one year of age.

V.R.E., 3/200, unimproved under atropin; V.L.E., 20/16. The retinoscopic test in the right eye shows approximately −0.50 in the vertical, and +1.50 in the horizontal.

The nasal one-third of the fairly superficial stratum of anterior cortex is irregularly opaque at different levels with contours everywhere well defined. The opacity continues on the mesial side in a more or less fascicular manner, and likewise involves a slightly larger area of the posterior cortex. A somewhat nasally displaced, 4 x 6 mm. horizontally oval, dense, almost chalk-white opacity without visible vascularization is seen to lie apparently on the vitreous surface of the posterior capsule (Fig. 1.)

A 3 mm. long, narrow, vertical slit prevails above in this dense opacity, through which red reflex is clearly visible with the ophthalmoscope, and from the same opacity five or six narrow, spindle-shaped, grayish-white striæ run forward and obliquely in downward and nasal directions. At a level between the cloudy posterior cortex and the deep chalk-white opacity are two somewhat rectangular shaped, unevenly dark-brown areas in the upper and lower nasal quadrants, respectively. A reddish hyaloid artery can be traced uninterruptedly from disc to lens, if viewed from the temporal side through the wide pupil (Figs. 1 and 2).

Clinical Diagnosis.—Right upward convergent squint; congenital stationary (?) cortical cataract; blood (?) in posterior cortex; persistent posterior fibrovascular sheath of the lens, with persistent hyaloid artery.

CLINICAL CASE 2.—Peter H., aged six, came on April 24, 1919, to my clinic at the Illinois Charitable Eye and Ear Infirmary on account of poor vision and broad excursions of both eyes. The mother furthermore volunteered the information that some time during the summer of 1918 a neighbor called her attention to the fact that "when the light struck his right eye a certain way the pupil 'showed up' white." Upon close questioning she declared that at no time had the eye been red, and that the child had never complained of pain.

V.R.E., shadows, no red reflex; V.L.E., fingers at 18 inches. Each palpebral fissure measures 21 mm.; both eyes are visibly smaller than normal, and the corneæ measure alike, 8 x 9 mm. The pupillary and ciliary zones of the iris are not definitely demarcated, and a network of delicate pupillary membrane threads stretch across the lower third of the right pupil (Fig. 3).

The right pupil dilates under atropin and cocain (ad. max. 5 mm.) irregularly below, where three short, narrow, triangular-shaped tags of iris appear to be pulled toward the center by the pupillary threads. No pigment deposits can be found on the anterior capsule. The left pupil dilates regularly to a maximum of 5 mm.

Completely surrounding the posterior surface of what appears to be a normal lens, one sees a glistening, uniformly white opacity, on the anterior surface of which an evidently single, plainly visible, mildly tortuous vessel of fair size runs completely across in the horizontal meridian. (See Fig. 4.) Four or five much finer vessels, taking the same general horizontal course, are placed below and to the temporal side.

A less dense opacity lies immediately behind the upper nasal quadrant of the left lens, and spreads out behind the upper one-fourth posterior surface as a fixed, cobweb-like network. Fundus details cannot be made out owing to the ocular excursions. A general anesthetic was denied for examination, but I feel satisfied that a hyaloid artery is not present, and that the refractive error is in the neighborhood of +6.00.

Clinical Diagnosis.—Microphthalmia, with persistent posterior fibrovascular sheath of the right lens; congenital cataract of the left lens.

The three bulbs to be described present multiple anomalies, but it is my purpose in this paper to confine the anatomic description to those anomalies only which correspond to the structures described in the two clinical cases, *i. e.*, the lens, the posterior lental opacity, and the hyaloid artery.

LABORATORY SPECIMEN A, CASE 3.—When John C., apparently normal baby, became one and a half years of age, the parents first noticed a gray spot behind the left pupil.

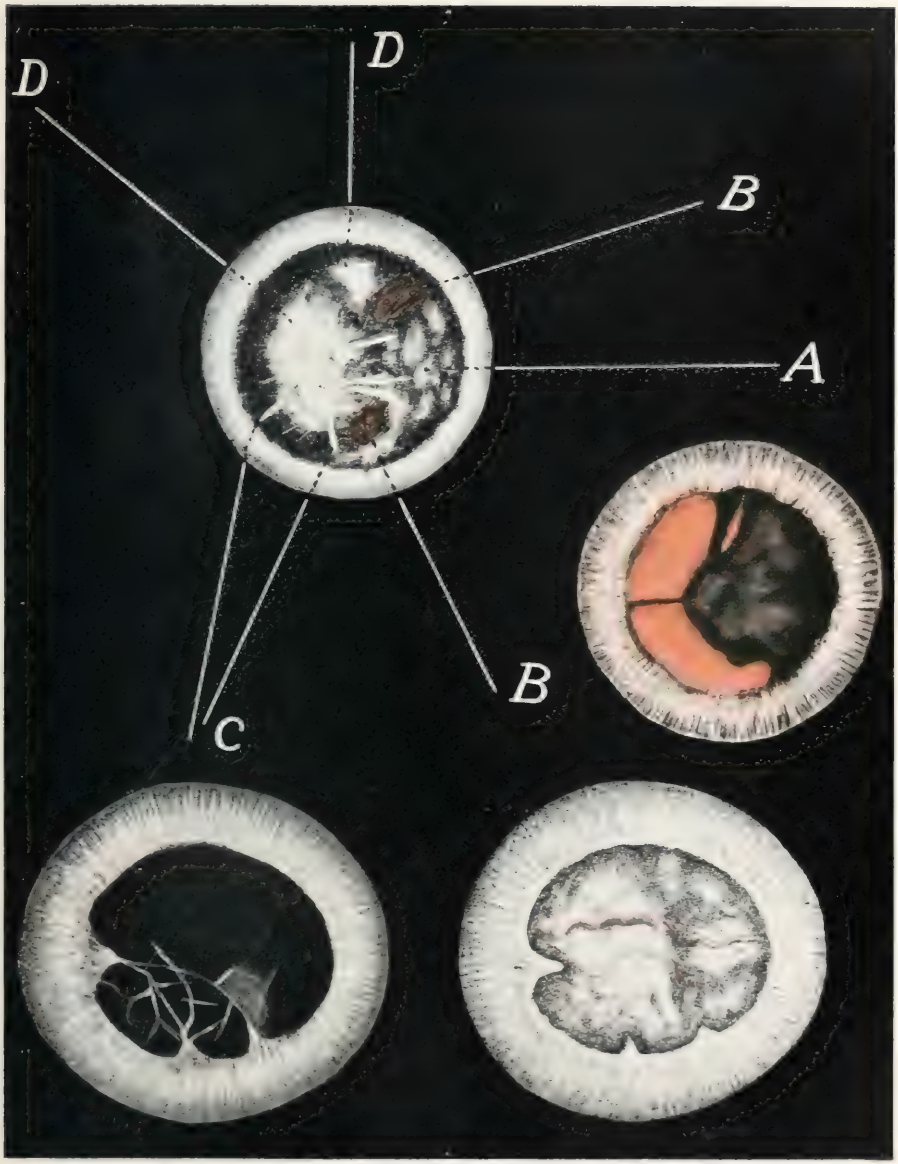


Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

Dr. Joseph Swan observed a vascularized white tissue behind the lens of an otherwise comparatively small eye which, after enucleating for suspected glioma, he gave to me for microscopic examination November 12, 1907.

Gross Findings.—Left eye, 14 x 13.5 x 13.5 mm.; cornea, 7 x 8 mm. The bulb was sectioned anteroposteriorly a trifle above the horizontal meridian. The lens, coffee-bean shaped, with the convexity forward, was apparently clear and measured 1.75 x 3.50 mm. with the long axis horizontal. It seemed to set back in a bluish-white semispheric-shaped mass, measuring 2 x 4.25 mm., from the most posterior convex surface of which a thin thread stretched across the vitreous to the head of the optic nerve. The fine, delicate ciliary processes were stretched inward and apparently attached to the most anterior border of that part of the sheath overlapping the equatorial region of the lens.

Microscopic Findings. The anterior capsule appears normal and the cubical cells continue around the equator, lining the posterior capsule throughout, with the exception of a few neighboring sections at the region of the posterior pole where the capsule appears to be absent, but I cannot satisfy myself that the gap is not an artefact (Fig. 6). The capsule at the equatorial region is swollen to some 6 microns and wavy, but gradually thins down behind to less than one micron at the posterior pole. Vacuoles, fissures, and small granular masses are scattered throughout the peripheral cortex.

Immediately behind the posterior capsule a loosely attached, incompact, fibrous-tissue mass extends for at least $\frac{1}{2}$ mm. beyond the broadest diameter of the lens both temporally and nasally. It is poor in cells and elastic fibers, but richly supplied with blood-vessels, many of which lie close to the posterior capsule (Fig. 5). The general direction of the anterior and posterior fibers of the mass is concentric with the posterior surface of the lens; particularly is this true of the posterior set, which have a laminated arrangement, while the intermediate fibers take an anteroposterior course. The hyaloid artery, filled with red blood-corpuscles, enters the membrane a trifle to the nasal side of the posterior pole of the mass, where its lumen measures 0.05 mm.; it then takes a sharp bend to the temporal side, then an axial

direction, and divides dichotomously. The lumen of a cross-section of the hyaloid artery, traversing the anterior vitreous, measures 0.03 mm. The ciliary processes and unretracted retina stretch inward and fuse with the anterior border of the sheath in all sections.

Anatomic Diagnosis.—Microphthalmia; persistent posterior fibrovascular sheath of the lens, with patent hyaloid artery attached.

Only features differing from those of specimen A will be regarded in the descriptions of the following specimens—B and C.

LABORATORY SPECIMEN B, CASE 4.—Two months after the birth of L. M. his parents noted that his right eye was smaller than his left, and, as they put it, "the pupil was discolored." When the infant was three months old Dr. Dwight Orcutt enucleated the eye because a shallow anterior chamber and a reddish-gray reflex behind the lens suggested glioma—January 27, 1908.

Gross Findings.—Right eye, 15 x 16 x 15 mm.; cornea, 8 x 9 mm.

The pupil was round, 4 mm. across, and the entire body of the iris was pushed forward and apparently applied to the posterior surface of the clear cornea. A superior calotte was made, the vitreous was clear, and a delicate, light colored, thread-like strand began at the center of the optic nerve and ended at the center of a dense white disc on the posterior surface of the lens. With the binocular loupe the dark-lined, lengthened, ciliary processes with the unreceded retina could be seen to extend inward to the white disc behind the lens.

Microscopic Findings.—All sections show the anterior stroma of the iris passing beyond the pupillary border and becoming attached to the anterior capsule. In some specimens the entire thickness of the iris margin bends backward at right angles, but in none of the sections is there any evidence that such adhesion is caused by plastic inflammation (Fig. 7).

The cubical cells and capsule surround the entire circumference of the lens except the region of the posterior pole, where a gap in the capsule is present. A spindle-shaped,

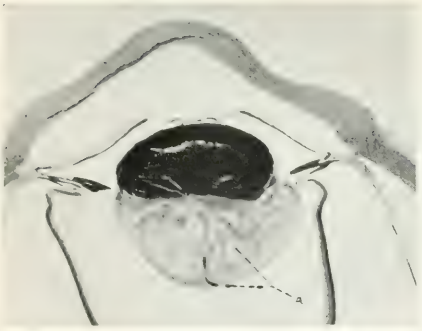


Fig. 5. Lab. Spec. A, Case 5.

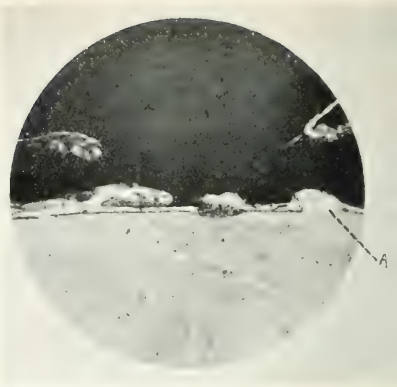


Fig. 6. Lab. Spec. A, Case 3.

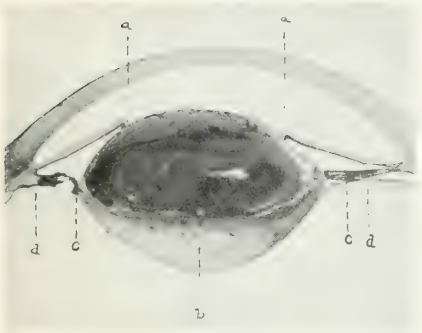


Fig. 7. Lab. Spec. B, Case 4.

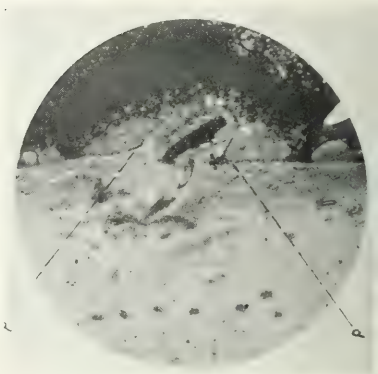


Fig. 8. Lab. Spec. B, Case 4.

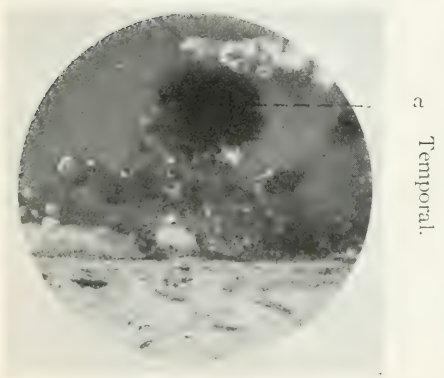


Fig. 9. Lab. Spec. B, Case 4.

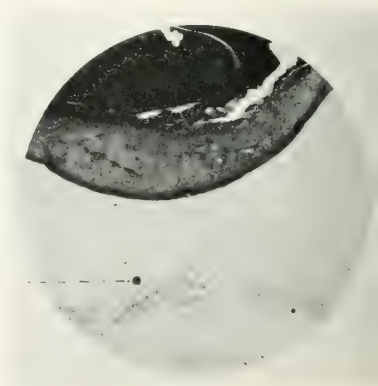
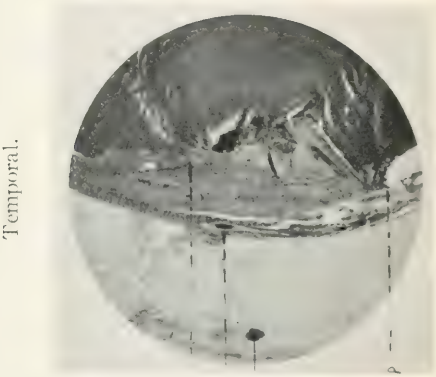


Fig. 10. Lab. Spec. B, Case 4.

Fig: 11. Lab. Spec. B, Case 4.

Fig. 12. Lab. Spec. C, Case 5.



a b c
Fig. 13. Lab. Spec. C, Case 5.

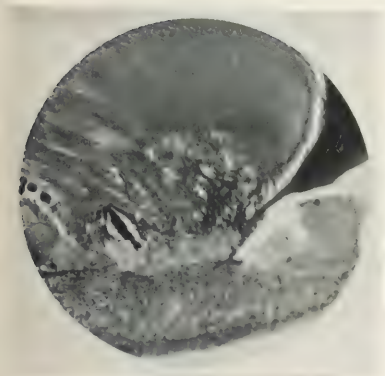


Fig. 14. Lab. Spec. C, Case 5.

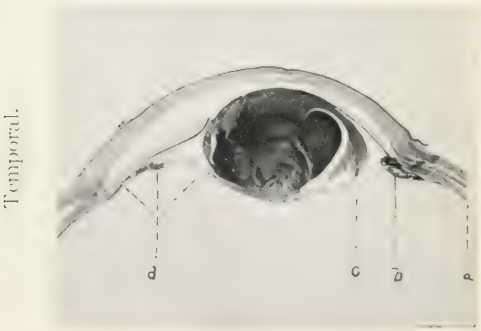


Fig. 15. Lab. Spec. C, Case 5.

brown, finely granular structure, surrounded by pigment-bearing connective-tissue cells, enters the gap, on both sides of which are a number of vacuolated cells and granular masses (Fig. 8).

Irregular, brownish areas, one quite large, dotted with small, deep-staining nuclei, are found farther forward in the cortex (blood ?) (Fig. 9). The sheath behind the lens is more intimately adherent to the posterior capsule, far more cell-rich, and somewhat more vascular than that described in specimen A. The cells consist of three types — those most posteriorly in the laminated area are markedly elongated and spindle-shaped, those in the body of the sheath are mostly oval, while anteriorly are many small round cells usually grouped about the blood-vessels. Small and abnormally large, wavy, interlacing fibers springing from the sheath and hyaloid artery, arterial diameter 1.20 mm., permeate the anterior vitreous. The ciliary processes are matted in the border of the sheath in all specimens (Figs. 10 and 11).

Anatomic Diagnosis.—Low-grade persistent pupillary membrane; persistent posterior fibrovascular sheath of the lens, with gap of the posterior capsule; hemorrhage in the lens; persistent hyaloid artery.

LABORATORY SPECIMEN C, CASE 5.—Dr. Oscar Dodd examined baby G., an infant three months old, and noted that the left lens was pushed forward on the nasal side, and a gray, vascular tissue was situated in the most anterior region of the vitreous. The tests with the ophthalmoscope and transilluminator suggested a new-growth, and the eye was enucleated for fear of glioma, November 15, 1912.

Gross Findings.—Left eye, 17 x 16.5 x 16.5 mm. The lens measures 3 x 5.25 mm., and the posterior sheath, displaced temporalward, is $\frac{1}{3}$ mm. thick at its greatest diameter (Fig. 12).

Microscopic Findings.—The capsule is entirely absent at the region of the posterior pole (Fig. 13). Elongated cells and fibers from the sheath press forward into the opening for a short distance, and several nearby areas of cortex show beginning calcification. Vacuolated cells and nucleated lens-

fibers stretch forward and temporalward from the connective tissue filling the gap (Fig. 14).

The distinguishing feature of this eye lies in the fact that on the nasal side the lens-fibers are laid down normally from the equatorial region, the ciliary processes are normal, and the boundary line of the ora serrata is normally placed; whereas on the temporal side the lining cells of the capsule continue backward to the gap, the elongated processes with the retina stretch behind the iris and fuse with the border of the posterior fibrovascular sheath (Fig. 15). So far as I am aware no like observation of the lens, ciliary body, and retina has been recorded to date.

Anatomic Diagnosis.—Persistent posterior fibrovascular sheath of the lens, with hyaloid artery; partial irregular development of the lens, limited to the temporal portion, constituting marked asymmetry.

As for treatment, it has been suggested that a needling, or for that matter a series of needlings, be performed in the ordinary way to attain the absorption of the soft lens material. After this has been accomplished the sheath must be dealt with, because it is unaffected by contact with aqueous.

Dilacerations have been done to no avail, because the elasticity of the membrane prevents retraction of the severed surfaces. Collins advises that the mass be deliberately pushed downward and backward into the vitreous cavity (1908).

Should such a procedure have been successful in cases 4 and 5, I am convinced that the anatomic relationship would have been so seriously disturbed, owing to the fusion of the sheath with ciliary processes and retina, that the eyes would have been lost from intra-ocular hemorrhage or glaucoma.

Conclusions.

1. Assuming that the existing condition of the two clinical cases is congenital, it is certain that had they been examined

during infancy or early childhood, the question of glioma would have been considered.

2. An opaque, vascular tissue behind the lens, whether completely or incompletely surrounding the posterior capsule in eyes presenting evident congenital anomalies, should strongly suggest the possibility of a persistent posterior fibrovascular sheath of the lens.

3. Pigment, particularly in the posterior portion of the lens, and a post-lental vascular membrane suggest a congenital defect of the posterior capsule and hemorrhage in the lens material.

DESCRIPTION OF FIGURES.

Fig. 1.—*a*, Anterior cortical cataract; *b*, hemorrhage in posterior cortex; *c*, striæ radiating forward; *d*, persistent posterior fibrovascular sheath.

Fig. 2.—Hyaloid artery.

Fig. 3.—Persistent thread-like pupillary membrane.

Fig. 4.—Persistent posterior fibrovascular sheath of the lens.

Fig. 5.—*a*, Persistent posterior fibrovascular sheath of the lens, with entrance of hyaloid artery.

Fig. 6.—*a*, Gap (?) of posterior capsule.

Fig. 7.—*a*, Persistent pupillary membrane; *b*, persistent posterior fibrovascular sheath; *c*, elongated processes, and *d*, unretracted retina.

Fig. 8.—*a*, Ends of posterior capsule, with gap wedged by connective tissue.

Fig. 9.—*a*, Hemorrhage in lens.

Fig. 10.—Vitreous fibers originating from the fibrovascular sheath and hyaloid artery.

Fig. 11.—Fibrovascular sheath, with entrance of patent hyaloid artery.

Fig. 12.—*a*, Persistent posterior fibrovascular sheath of the lens; *b*, normal development of lens-fibers at the equator.

Fig. 13.—*a*, Ends of posterior capsule, with gap filled in with connective tissue; *b*, entrance of patent hyaloid artery into sheath, with vitreous fibers coming from sheath, and *c*, artery.

Fig. 14.—Vacuolated cells and nucleated fibers anterior to connective tissue filling gap.

Fig. 15.—*a*, Ora serrata; *b*, normal ciliary processes; *c*, normal lens-fiber development; *d*, embryonic ciliary processes with unreceded retina fusing with sheath on temporal side.

ANTIDIPHTHERITIC SERUM IN SEVERE OCULAR INFECTIONS, WITH SPECIAL REFERENCE TO HYPOPYON KERATITIS.*

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INTRODUCTION.—This branch of ocular therapeutics (serum therapy) has been characterized, more than any other, perhaps, by the most conflicting opinions and varied observations, the most enthusiastic—too enthusiastic, on the one hand, and the most conservative—too skeptical, on the other. And since Wright announced his theory of opsonins and formulated the opsonic index of phagocytic activity, investigators of every country have striven by every means of modern research to standardize bacteria and their many kindred strains, to classify their peculiarities, to measure the virulence of each, to minimize and increase this virulence, and to utilize them at will by innumerable methods of vaccination and inoculation for diagnostic, prophylactic, and therapeutic purposes. And the result of these investigations

* Candidate's thesis for membership accepted by the Committee on Theses.

has been that certain therapeutic means have been intrusted to the ophthalmologist, which have broadened his field of usefulness and made more directly curative the systemic ocular conditions constantly under his care and direction. For example, may I point out, briefly, the most important of these—the oldest of all methods of immunity, originated by Jenner—that of small-pox vaccination and its well-kownn far-reaching influence on the frequency of blindness; also the healing action of Behring's antitoxic diphtheritic serum upon conjunctivitis produced by Loeffler's bacillus; the effect of antitetanic serum occasionally indicated in ophthalmology; the theory and practice of serum therapy in hay-fever that is of peculiar interest to the ophthalmologist, since the use of Dunbar's "Pollantin" and Weichart's "Graminol," to the employment of those preparations more definitely and specifically active of the present time. The jequiritol-serum of Roemer, to combat violent jequiritol ophthalmia, and to prevent complications, is also classed as an antitoxic serum in this branch of ocular therapeutics. The field of bactericidal serum therapy, in which the pneumococcic serum of Roemer and Merk and the polyvalent serum of Roemer and others have been exploited and employed with varying results, due to the practical difficulties in obtaining an autogenous or specific effect against the particular strain of organism, the same being true of streptococcal and staphylococcal serum or vaccine, the means of active immunization with vaccines from microörganisms cultivated from the eye of the patient being theoretically most acceptable, but in practice most difficult and uncertain to carry out. The gonococcic serum or vaccine effect upon metastatic iritis has proved to be most efficacious in the hands of those who have employed it, in contradistinction to its effect upon conjunctivitis, where theoretically and practically the vaccine or serum has seemed ineffectual. Flexner's meningococcic serum is useful in ophthalmology through its favorable

influence on the general disease; and finally the tuberculin treatment of ocular infections as practised by von Hippel, Percival Hay, Maitland Ramsay, Weeks, and many others, and which has become, through careful clinical observation of innumerable cases and under the care and varied treatment of many reliable observers, a therapeutic measure of value not to be estimated.

When one recalls, then, these important therapeutic agents offered to the ophthalmologist through long-continued experimental and clinical investigation, one is struck by the value of them and by the records and results, and one is stimulated to carry on, within conservative limits, the study and research of serum therapy. Following upon and coming out of the study and investigations just related, the theory and practice of paraspecific therapy have been evolved. This field, like that of the proteins, is opposed to or unexplained according to known standards of bacterial activity in the human body. Experimental and clinical results have not coincided. The older theories of immunity have not explained the results claimed by the practice of paraspecific therapy. On the other hand, clinical observations of its effect have not met the demands of the fundamentals of bacteriology. The question, therefore, of the place in ophthalmology to be accorded paraspecific therapy and the theory of its activity, if any, is one not yet definitely determined.

LITERATURE. –Ophthalmic literature, since 1907, is fairly crowded with the theory, experiments, and clinical observations of many authors on this subject. Darier, perhaps more than any other, has championed the cause of paraspecific therapy, and through the reports of his results encouraged the practice of it by numerous collaborators, who more or less confirmed his findings, while at the same time he provoked a storm of criticism from those closely adherent to bacteriologic principles. And so two schools of writers and

investigators have arisen who seem far apart in their theories —further apart in their experiments and furthest apart in their observations and analysis of results. The one holds that the practice of antidiphtheritic serum in non-diphtheritic conditions of the eye is opposed by the accumulative evidence of the strictly specific reaction of the tissues against poison and foreign substance of every kind; also that it has no effect upon the opsonic index of the experimented animal, nor does it increase agglutination or complement fixation; in other words, that purely experimental observations have not demonstrated that diphtheritic antitoxin is able of itself to combat non-diphtheritic ocular infections. Axenfeld, Happe, and von Szily made experimental tests on rabbits by previously immunizing and also treating them daily after infection with relatively large doses of Behring's and Roux's serum. Accurately measured minute quantities of culture of staphylococci or pneumococci were injected into the anterior chamber or cornea. A control rabbit was always injected in the same manner. These experiments had a completely negative effect. When the injections of pneumococci were made into the vitreous, the rabbits not only developed panophthalmitis, but died in a few days, exactly as did the control animals. They concluded, from these experiments, that the serum did not exhibit any influence against either local or general infection. It is admitted, however, that these experiments do not solve the question for the human subject. Napp and von Michel warned their contemporaries against the enthusiasm over paraspecific therapy, no specific results having been observed by them. Roemer states that "it is self-evident, from the difficulties that beset the specific etiologic therapy, that non-specific serum therapy is hopeless in ulcus serpens; furthermore, that this fact was to have been expected from the results of the study of immunity, for there is no scientific foundation for the idea that non-specific serums, as

diphtheria serum and Deutschmann's yeast serum, can possibly produce any effect upon a pneumococcal infection of the cornea." E. Janson experimented with normal rabbits and those previously treated with diphtheritic antitoxin. He used B. typhosus and paratyphosus for the agglutination experiments, and for the others he used the staphylococcus and pneumococcus. As regards agglutination, complement fixation, and opsonic index, there was no appreciable difference between the serum of the treated and non-treated animals. Neither was there any beneficial result from treatment of experimental infections of the anterior segment of the eye. Bietti and Cavara have concluded from their work on animals that antidiphtheritic serum is ineffective for combating post-operative experimental infections, both when injected under the skin and when administered by mouth. Neither do they believe clinical experience clearly demonstrates that antidiphtheritic serum is able of itself to combat ocular infections. The same conclusions were reached as regards experimental research with Deutschmann's serum E and his serum D. There was no difference in the opsonic index and no change in the agglutinating power in the treated and non-treated animals.

On the other hand, Darier and his followers maintained that paraspecific therapy is a means of defense of the organism in all infections, local and general; that antidiphtheritic serum is the most trustworthy of the serums employed, because of its potent eutrophic, stimulant, and anti-infective properties. They claim that its action on the organism is by its potent effect upon all the "anatomic elements" by placing it "in a state of defense distributed, each after its manner, in the circulation —antitoxins, immunisins, and antibodies. The glandular elements, thyroid, suprarenals, spleen, liver, testicles, and lymphatic nodes, as well as the nervous, muscular, and osseous tissues, are all in a state of organic hyperactivity." Predtetschensky insists that the

antidiphtheritic serum contains "stimulins,"—substances that stimulate the leukocytes to increased activity,—as do certain other substances, such as concentrations of nuclein acid, etc., and also horse serum (Axenfeld). Peabody, Rosenberger, and Randle call attention to the effect of antidiphtheritic serum upon meningococci, and state the effect is "antagonistic" and inhibits their growth, similar to the action of certain microbes in nutritive media in consequence of the presence of other germs. Deutschmann has reported experiments with his yeast serum upon animals after infecting the anterior chamber with staphylococci, streptococci, pneumococci, or tubercle bacilli, and the effect was markedly favorable in the rabbits infected with pneumococci. M. Neisser discovered that yeast serum in the vitreous stimulates somewhat the action of leukocytes against staphylococci, thus increasing phagocytosis. The partisans of paraspecific serum therapy do not deny or doubt the specific nature of antitoxin and of the other specific antibodies, but they do adhere to the theory of paraspecificity, because the process of antibacterial immunization is by no means explained by hitherto ascertained specific effects, and go so far as to claim that probably the whole therapeutic effect of streptococcic and pneumococcic serums and others is an effect that may not be in itself sufficiently specific, but also acts by its non-specific stimulating and other properties. Antidiphtheritic serum, antitetanic, yeast serum, and normal horse serum are said to act similarly on the human subject. Of these, antidiphtheritic serum has been the most popular, although whatever effect or advantage is claimed of one is accepted as an argument to some extent in favor of all—the theory of paraspecific therapy.

The accumulative evidence of clinical observation alone seems to rest on the side of paraspecific serums, judging by the reports of numerous authors who have employed them. Axenfeld remarks that "clinical observation on human sub-

jects must always speak the decisive word, although by it no mathematical certainty can be obtained and also something of subjectivity always clings to it. It is possible that a result which we do not obtain in animals may nevertheless occur in the human body." Darier heads the list of those using antidiphtheritic serum, having employed it in hundreds of cases and with results that appear unusual. His experience dates back to 1904. In La Clinique Ophthalmologique he repeatedly defends himself and his convictions, and in the 1910 volume he states that his own enthusiasm during the past three years has been experienced and met with almost simultaneously in Germany and France and with absolutely different serums, and that the specific effects obtained by Roemer with his antipneumococcic serum were not so numerous or so favorable as those obtained by himself with antidiphtheritic serum, or by Deutschmann, von Hippel, and Zimmermann with yeast serum and horse serum; and, furthermore, that the cases were now so numerous that there was no longer any doubt as to the real efficacy of paraspecific therapy.

As early as 1907 Deutschmann published his experience with his yeast serum, and since that time has reported results so striking that he has been taken to task on numerous occasions for statements difficult of acceptance. At the same time, 1907, Darier was experimenting in a similar direction with the serum of Roux and Behring, and was beginning to report most favorable results, obtained in conjunction with the usual local and surgical treatment of infections of the eye. M. Teulières, in the same year, arrived at results similar to those of Darier in the use of antidiphtheritic serum. In 1908 Axenfeld threw a chill over the enthusiasm of those reporting such brilliant clinical results without experimental evidence to prove what they claimed, and appealed for a high standard of experimental and clinical work. At the same time Happe presented the result of 100 experiments

on rabbits, including infections of the vitreous, anterior chamber, and cornea, and concluded that the value of Deutschmann's serum and antidiphtheritic serum had not been demonstrated by his experiments. Zimmermann reported 11 cases in which wounds and ulcus serpens were greatly benefited. Antonelli believed, from his clinical experience, that "nothing was to be feared" from the use of antidiphtheritic serum, and that his results, especially in severe wounds of the globe, led him to advocate it. Teulières in this year concluded that the serum of Roux was undoubtedly beneficial when used in conjunction with the usual local treatment. Bailliart reported four cases of hypopyon keratitis in which he believed the result from antidiphtheritic serum was strikingly favorable. In 1909, besides Darier, who reported a large series of miscellaneous cases which he claimed to have benefited by antidiphtheritic serum, Scheuermann presented eight cases following trauma; Dehenne and Bailliart reported post-operative infections; and Dorr used it in accidental injury cases, all having noted favorable action of the serum. Deschamps reported a suppurative iritis following grippe, and Heydar-Bey a post-influenzal neuroretinitis. Angiolella reported five cases, Frogier 12 cases, Zimmermann 28 cases, these observers meeting with and believing in effective results from the serum. J. S. Fernandez ventured the use of the serum as a prophylactic measure in injuries, both accidental and operative. In 1910 Deutschmann presented 117 cases treated by his "polyvalent yeast serum," and in which he claimed definitely good results; von Hippel also reported such glowing results with Deutschmann's serum that Axenfeld criticized them as being evidence of doubtful significance. Weeks, in presenting the status of serum therapy in ophthalmology at Budapest, was non-committal as to the non-specific use of diphtheritic antitoxin. During this year favorable results from non-specific use of antidiphtheritic serum were re-

ported by Alexandroff, Menacho, Jaqueau, Fernandez, Yvert, Piccaluga, and others. In 1911 Kasas refers to the effect of diphtheritic serum on the symptomatology of corneal ulcer and inflammation of the iris in the cases of his experience, and is impressed by the relief of pain and the definite improvement in the healing process following the use of the serum. Mayweg reported a case of panophthalmitis which was relieved by antidiphtheritic serum and so checked in its progress that it was unnecessary to enucleate. Darier grows bolder in urging the serum in iritis, whether tubercular, syphilitic, gonococcal, or rheumatic, and suggests the use of it by mouth. During 1912 Darier, Janson, and Dorr reported further investigations, Janson giving the results of experimental work that proved the negative effect of antidiphtheritic serum and decrying the enthusiasm of the French writers, while Dorr presented 36 cases of grave corneal ulcer favorably affected by yeast serum. In 1913 R. Solm reported experiments on rabbits with pneumococcic serum and without any result whatever, but, on the other hand, in man the serum showed definitely curative properties in panophthalmitis and other suppurative inflammations in which he employed it. He administered it by mouth in large doses and hypodermically. In 1914 Darier employed antidiphtheritic serum at the earliest possible moment in severe infections of the eye, during the period when a bacterial diagnosis is being made and during the time necessary to prepare a specific serum. This relieves pain and is usually so effectual that specific serum may be unnecessary. He urges the administration by mouth. Ribas Valero reports in detail a case of corneal abscess that resisted the usual classic treatment, and after injection of 4000 units of antidiphtheritic serum in seventy-two hours there was disappearance of the purulent infiltration, with marked lessening of reaction and relief of pain. During 1915 Frogier recommended oral administration of antidiphtheritic serum,

and relates a wide experience in the use of the serum for paraspecific purposes. He finds it gives constant results in the relief of pain, has a definite analgesic and euphoric action, checks the infectious process, and assists in the resorption of infiltration and exudates and in the repair of tissue. Lafont, Dupont, and Heckenroth report a series of cases treated with serums, and in 49 of them they were most favorably impressed by the treatment. Bietti and Cavara in this year reported their experiments already referred to.

ADMINISTRATION AND DOSAGE.—Diphtheritic antitoxin has been administered hypodermically, intravenously, by the mouth, and by subconjunctival injection. It was first employed, as was originally intended for specific purposes, by hypodermic use, and it was through this method that its apparent beneficial effect was first noted. Through a larger experience, evidently as a result of anaphylactic effects in certain cases, the oral administration has been strongly urged by its most ardent supporters, with the assurance that no general ill effects have been observed from this method and that clinical results are equally as good. Darier has advocated the subconjunctival injection in desperate cases, but his enthusiasm in this direction has not been shared by others for reason of its ultra-unscientific basis. It operates by increasing local irritability and cell activity, as does any other irritating solution. Undoubtedly there have arisen anaphylactic effects sufficiently alarming to suggest the oral administration of the serum, although I have failed to find such reports in the literature. Many have observed a slight rise of temperature, even to the degree of 103, with nausea, some gastro-intestinal disturbances, an occasional erythema, joint pains, restlessness, etc., but which disappeared rapidly and without serious consequences. On the other hand, so frequently has it been employed without the least complication that it is reasonable to suppose one may become careless and bold in the administration of

large doses, and certain individuals sensitive to its action may suffer severely, even fatally, from it. Darier claims that the antidiphtheritic serum has an action ten times more intense than normal horse serum. With 10 c.c. of the serum of Roux one obtains an effect, he says, equal to 100 c.c. of horse serum. He concludes: First, that with the rabbit some grave infections have been favorably influenced by serum given by mouth or by injections. In man panophthalmitis has been benefited, and many other cases have been cured by the serum given by mouth. Second, purulent infections of the eye have been influenced more vitally and better by serum given by mouth than by injections. Third, for prophylactic purposes the subcutaneous injection is preferable. Fourth, 10 to 25 c.c. a day by mouth at the first signs of infection almost invariably effects a complete cure. Mongour and Fonquet, in their book, "Serum de Cheval Normal en Therapeutique," draw the following conclusions: Horse serum is chosen by preference because it exposes less than all others to anaphylactic accidents. First, it activates the coagulation of the blood, therefore is indicated in hemorrhages and more particularly in hemophilia. Second, it activates the hematopoietic system and therefore is valuable in anemia. Third, it stimulates general phagocytosis, thereby explaining the influence upon infections and intoxications. Fourth, it favors local diapedesis of white cells, thanks to its chemotactic properties, therefore is employed in burns and also in peritonitis. Furthermore, they conclude that the administration by subcutaneous and intravenous methods exposes to anaphylactic accidents, but this is not the case when given by mouth. They add that, for want of normal horse serum, so difficult to obtain, one may utilize the antidiphtheritic serum, which gives exactly the same results and contains the same properties.

As to the time of administration, the serum has been

given at various times relative to the severity of the involvement and the employment of other treatment. It has been especially urged that it be given at the earliest possible moment after hospital treatment is demanded. The earlier the treatment is begun, the more effectual is believed to be the result. Darier and his followers insist that it is often given too late, just as antitetanic serum and antidiphtheritic serum for specific purposes are often administered after permanent destructive changes have taken place. On the other hand, they believe that it is in the grave cases of infection, where the usual local treatment, however intensely applied, may fail, that administered early the paraspecific effect is of the most value. Therefore it is urged that every case be treated early, but the effect in grossly neglected cases is remarkable. As to the frequency of administration, there is difference of opinion, Darier giving by mouth a moderate dose every day for three or four days. He also advocates hypodermic injections of a moderate dose every other day for three doses. Others rely upon one dose of large amount, while others have employed it every day in moderate amount by the hypodermic method. Zimmermann (Goerlitz) believes that if improvement is not definitely noted in three or four days after injection, no effect will be obtained by this therapy, but he has reported remarkable results from two injections only, and believes the effect is transient and not at all cumulative. Others share this opinion. The usual interval between doses has been from one to three days, and I have found no instance where seven days have intervened. Together with administration of the serum, many forms of local treatment have been employed, depending for the most part on the severity and extent of the process involved in the individual case—the classic treatment of hot fomentations, atropin and local antiseptic measures, cautery (chemical and galvanic), paracentesis of cornea, transfixation of Saemisch, conjunctival autoplasty, strong

dionin solution, and subconjunctival injections of antidiphtheritic serum, salt solution, or of cyanid of mercury.

As to the dose to be administered, there are many opinions. In 1909 Darier recommended the injection of 10 c.c., equivalent to about 2500 units, and repeated every day for three days. Later in 1913 he advocated 20 c.c. by mouth, and frequently only 10 c.c. in eleven times the amount of physiologic salt solution by mouth was sufficient, but it may be repeated every day for three or four days if necessary. Verrey and Frogier, after very large experience, regard the administration of 10 c.c. of serum in 110 c.c. salt solution by mouth as the best and most effectual of all the means and dosage. Piccaluga employed 800 units hypodermically; Fernandez employed 2000 and 1000 units; Castresana used intravenously 10 c.c. in 100 gm. of solution saturated to 7 per cent.; Jacqueau varied the dose with the gravity of the infection, usually employing 10 c.c. every day for four days; Alexandroff never gave more than 10 c.c. for four injections. Zimmermann maintains that small doses are just as efficacious as, if not more so than, large doses; that 1500 units is usually sufficient, and he has found it necessary to repeat it rarely. In this connection he reports 28 cases of hypopyon ulcer and infections after trauma, in which 17 cases were given only 1500 units, 3 cases given 2500 units, 5 cases given 3000 units, and 3 cases given 4000 units in all, not more than 1500 units being employed at a dose. Large doses of the serum have been administered, but those observers who have had largest experience have shown a definite preference for smaller doses repeated every day or two for three or four injections. Ribas Valero used 20 c.c. hypodermically, and also Angiolella gave injections of 5000 units, both reporting striking results. The advocates of large doses base their reasoning upon the theory of non-vascularity of the cornea, aqueous, and vitreous, which therefore require larger doses than dis-

ease elsewhere, it being claimed that these doses cause no harm and aid the ocular process by producing a negative phase of cellular activity. The minimum dose used, so far as I have been able to find, has been 500 units, while the maximum dose was 8000 units. In all the least amount regarded as necessary in a single case has been 800 units, and the maximum, 15,000 units. The minimum time before a change was observed after administration of an injection was twelve hours (this after a large and also after a moderate dose), the maximum time was seventy-two hours, the usual time being twenty-four to forty-eight hours. The maximum time over which the serum has been employed in a single case was six weeks, injections being given at infrequent intervals.

INDICATIONS.—The broad field of usefulness to which paraspecific therapy, especially antidiphtheritic serum, may be employed, should it deserve a place in ophthalmic therapeutics, is quite evident, even to the casual observer. Axenfeld stated, at the Sheffield meeting of the British Medical Association (1908): "If one or other of the non-specific sera should really prove so polyvalent that it is capable of acting at the same time against a number of different bacterial species, it would be a great advance." He clings here to the theory of specificity as being the necessary sine qua non, and does not accept the probability, founded upon innumerable clinical observations, of an action indirect or other than directly specific, to account for the effect of paraspecific therapy.

Diphtheritic antitoxin has been administered for disease of almost every anatomic segment of the eye, also for the different infections to which it is exposed, as well as for prophylactic purposes. It has been employed in dacryocystitis and phlegmon of the sac, recurrent styes, persistent ulcerative blepharitis, purulent and other types of conjunctivitis, including trachoma, purulent corneal ulcer,

hypopyon keratitis and abscess of the cornea, interstitial keratitis, iritis (especially traumatic and purulent), iridocyclitis abscess of vitreous, neuroretinitis, panophthalmitis, and orbital phlegmon. Infections of the eye in which it has received most praise include especially diphtheritic, pneumococcic, and staphylococcic processes, whereas it has been tried out in all of them, particularly streptococcic, mixed infections, diplobacillary infection, influenzal, syphilitic, gonorrheal, and tuberculous. For prophylactic purposes it has been used with varying degrees of speculation in cases of penetrating wounds, preoperative conditions with infection of the conjunctiva and lacrimal passages, glaucoma, traumatic cataract, etc., and following upon or incident to operative procedures of responsibility and of doubtful outcome. No statistics, however, bearing upon the efficacy of such measures have been published to my knowledge, but it has been urged, on the theory of its curative value and upon the basis of its prophylactic influence from specific effects, as in the case of antitetanic serum therapy. An indication of some importance is that suggested by Darier, who emphasizes the benefits to be obtained by the early administration of antidiphtheritic serum, which is always available, during the period in which a bacterial diagnosis is being made of a critically infectious condition. It is in these cases that early treatment is most needed, and to delay, while the bacterial diagnosis is being made and an autogenous or specific vaccine or serum is being prepared or procured, would lose valuable time in which perhaps irreparable damage and even loss of the globe may take place. Especially in penetrating wounds, traumatic or operative, with an infection evidently present from the clinical appearance, it is emphasized that early administration of antidiphtheritic serum may turn the tide of the process before a specific serum or vaccine could be secured. Even then the virulence of autogenous or

specific serums is so frivolous and uncertain in its preparation, dosage, and potency that by the time it could be employed its specific properties may prove useless against a more advanced and more virulent process. Furthermore, in many instances specific serum or vaccine cannot be had for many days, when the only treatment by that time indicated may be that of enucleation.

To record here the results from treatment with antidiphtheritic serum, as reported constantly by many authors during the past eleven years, would make too voluminous a narrative, and is quite unnecessary as a point of information or of argument. It is of real importance, however, for a thorough understanding of the subject, to summarize these results both as effecting more directly certain anatomic segments than others, and as occurring in certain infections more profoundly and definitely than in others. Suffice it to say, regarding the former, that the non-vascular structures, the cornea, aqueous, lens, and vitreous, seem to have received more attention and to have been more strikingly affected than involvement of the vascular elements of the eye, the lids, conjunctiva, orbit, and uvea. Many favorable results, which, however, may have been due to local and other treatment, are reported in infections of the vascular parts, but these have not been such as to compete with those obtained by specific serums, which, of course, combats an infection of the vascular structures of the eye in the same manner as that of the skin and vascular organs of the body. It is in the involvement of the refractive media, non-vascular structures, which, taken together, form by far the greater part of the eyeball, and in which bacteria flourish in an unusual manner, that results from paraspecific therapy would seem to claim an important place in ocular therapeutics. In cases of corneal ulcer and abscess, hypopyon keratitis, and infections of the anterior segment from penetrating wounds and operative procedures, that actual curative processes have

been insisted upon, while in panophthalmitis and abscess of the vitreous curative reactions and amelioration of symptoms have been noted by many clinical observers. Isolated instances of phlegmon of the orbit and of the vitreous entirely cured by paraspecific therapy have been cited, but so unreasonably wonderful have been these results that their real significance cannot be credited. In this connection Darier has repeatedly stated that paraspecific serum therapy will not cure all ocular infections any more than antidiphtheritic serum will cure all diphtheritics nor mercury will cure all syphilitics.

As to the character of the infection involved, staphylococcic and pneumococcic infections have shown the most marked effects from the serum. Streptococcic infections have not responded at all. Its effect upon syphilitic, gonorrheal, and tuberculous infections has not been consistent in any degree, although many reports of satisfactory results have been published. Where syphilis, gonorrhea, or tuberculosis has been a complication of the pneumococcic or staphylococcic process in a non-vascular structure of the eye, the systemic condition has not seemed to prevent the usual effect of the serum upon the local infection.

CASES

In my study and research of the question of paraspecific therapy I have employed during the past two years antidiphtheritic serum in many cases of severe ocular infection, and have carefully observed almost daily the changes to be noted by its use. I have also recorded a history of these cases, and a preliminary examination (appearance of the particular involvement in minute detail), as well as the course and treatment, including especially the dates of treatment and of definite changes in the pathologic process. At this time I am able to report thirty cases, of which twenty-three are hypopyon keratitis, two infections of ante-

rior chamber after penetrating wound, four panophthalmitis, and one ulcus serpens.

CASE (A) I.—F. B., aged fifty-seven years. Hypopyon keratitis. Admitted to New York Eye and Ear Infirmary April 23, 1917. History: Four days before, struck in right eye by a stone of fair size. Examination: Central deep ulcer of cornea, 3.5 x 3.5 mm. in size, with undermined margins, especially at its lower portion, no marked area of infiltration, though rest of cornea slightly hazy with loss of luster; conjunctival and iritic reaction was intense; anterior chamber contained hypopyon, 2 mm. deep; iris contracted to small pupil; pupillary space fairly clear; vision, fingers at two feet peripherally. The organism found in a smear from the ulcer was the pneumococcus. Treatment and course: In spite of the usual treatment of cauterization (bichlorid 1:500), hot applications, atropin and bichlorid vaselin (1:5000) for three days, the condition remained unimproved. April 26th, 5000 units of antidiphtheritic serum were injected hypodermically. In twenty-four hours the hypopyon was apparently being absorbed, and in forty-eight hours it had disappeared. No pain was complained of, and local treatment was continued. One week afterward, May 5th, hypopyon, 1 mm. deep, appeared over night, and 5000 units of the serum were again injected. At the end of thirty-six hours it had disappeared. Continuation of the same local treatment, dionin being added in the late stages, produced rapid healing. Discharged May 25, 1917.

Remarks.—Here there appears to have been a direct systemic effect of some character, revealing itself in the disappearance of the hypopyon. In all, 10,000 units injected; time in hospital after first injection, twenty-eight days.

CASE (A) II.—J. S., aged fifty-nine years. Hypopyon keratitis. Admitted to New York Eye and Ear Infirmary May 19, 1917. History: Nine days before a small piece of iron flew into left eye. The particle was removed by a friend, but the eye had become gradually worse. Examination: Central deep ulcer of cornea, 1.5 x 2 mm. in size, with an areola about it deeply infiltrating, other corneal tissue being fairly clear and transparent; conjunctival and

iritic reaction intense; hypopyon, 1.5 mm. deep; iris contracted to a small pupil and attached to lens capsule; pupillary space hazy; vision, hand movements. Smear showed the pneumococcus. Treatment and course: On admission the ulcer was cauterized with carbolic acid (concentrated) and alcohol (45 per cent.), the usual local treatment given, and 5000 units of antidiphtheritic serum were injected. Forty-eight hours afterward hypopyon had disappeared; iris almost entirely free, no pain. On May 22d, three days following first injection, 2000 units of the serum were injected. No return of hypopyon, rapid healing; discharged May 29, 1917; vision, ultimately 20/30.

Remarks.—Local treatment may have been the whole or determining influence here, and yet the rapid healing, prompt disappearance of hypopyon, and absorption of the infiltrated area, finally allowing good vision, may point to a systemic effect in this case. In all, 7000 units injected; time in hospital, ten days.

CASE (A) III.—M. S., aged fifty years. Hypopyon keratitis with severe iritis. Admitted to the hospital May 21, 1917. History: Three weeks previously right eye struck by a piece of plaster. Examination: The entire nasal three-quarters of cornea involved, with two very deep areas of active ulceration in its center, each about 1.5 x 1.5 mm. in size, other corneal tissue being diffusely hazy; conjunctival and iritic reaction of the most intense character; hypopyon 3 mm. deep; iris partly dilated, the inner portion firmly attached to lens capsule; pupillary space very cloudy; vision, hand movements. The organism found was the pneumococcus. Treatment and course: Usual local treatment was employed, except prolonged cauterization with bichlorid (1:500) was made, and the patient confined to bed, the eye receiving a pressure bandage between treatments. On the second day, 5000 units of antidiphtheritic serum were injected. In twenty-four to forty-eight hours pain was relieved; the iris became more widely dilated. May 25th, 2000 units were injected. In twenty-four hours one-half of the hypopyon had disappeared; margins of ulcers showed definite healing changes; iris almost free of synechiæ. May 27th, healing continued, hypopyon dimin-

ishing. May 29th, 2000 units injected, and the following day the active ulcerated areas were almost clean—no hypopyon. On June 1st the ulcer débris was rapidly clearing away, iritic reaction broken, and patient discharged June 8, 1917, with unusually small amount of opacity for such an extensive involvement of corneal substance.

Remarks.—This case may indicate a definite systemic influence, because of the time before admittance without improvement, a positive relationship between injections and effect, the rapidity of this effect, controlled without Saemisch or spontaneous collapse of anterior chamber, and the unusual clearing away of débris and opacity. In all, 9000 units injected; time in hospital, eighteen days.

CASE (A) IV.—B. L., aged forty-seven years. Hypopyon keratitis. Admitted to New York Eye and Ear Infirmary May 29, 1917. History: Four days previously a foreign body struck left eye, treated without effect. Examination: Central ulcer of cornea, 3 x 4 mm. in size, with points of undermining and points of infiltration, other corneal tissue being fairly clear and transparent; hypopyon 2 mm. deep; iris contracted; pupillary space fairly clear; vision, fingers about four feet. The pneumococcus was found. Treatment and course: Regular local treatment, cauterization with bichlorid 1:500, and 5000 units of antidiphtheritic serum injected on day of admission. In twenty-four hours there was improvement in symptoms and in the amount of hypopyon, and in forty-eight hours only a trace of hypopyon could be detected. June 1st, 2000 units injected; following day, no hypopyon. Pain returned on June 5th, but no hypopyon, and 2000 units injected. Relief of symptoms and rapid recovery followed. Discharged June 14th; vision, 20/200.

Remarks.—Results may be due entirely to local treatment, but it is interesting to note the relationship of injections to hypopyon and symptoms, no severe cautery being used and no Saemisch made. In hospital sixteen days; 9000 units injected.

CASE (A) V.—J. S., aged forty-eight years. Abscess of cornea with hypopyon. Admitted to New York Eye and Ear Infirmary July 2, 1917. History: Two weeks before, struck in right eye; no treatment used. Examination:

Central abscess of cornea, 3.5 x 4 mm. in size, with diffuse infiltration of cornea, the surface of abscess raised above the normal level of cornea, other corneal tissue hazy; conjunctival and iritic injection intense, moderate chemosis; hypopyon 4.5 mm. deep; iris contracted to small pupil, and pupillary space partly filled with hypopyon; vision, hand movements. Treatment and course: On admission, complete evacuation of the abscess was made by numerous incisions through it, each incision passing through the center and into its margins; it was then cauterized carefully with carbolic acid (concentrated) and alcohol (45 per cent.); atropin and bichlorid (1:5000) vaselin applied locally following warm salt solution irrigation four times a day, bandage, bed; 5000 units antidiphtheritic serum were injected. During the night anterior chamber collapsed. Following day pain relieved, no hypopyon. Two thousand units injected on July 3d, 4th, and 6th. Improvement was rapid; ulcer healed on July 13th sufficiently to permit patient's discharge, but he was kept under observation until July 25th. Subsequent iridectomy; vision, 20/100.

Remarks.—Local and surgical treatment may have been sufficient in this case, but the rapid healing and clearing of the ulcer are interesting to note. In hospital eleven days; 11,000 units injected.

CASE (A) VI.—D. M., aged fifty-five years. Hypopyon keratitis. Admitted to New York Eye and Ear Infirmary July 6, 1917. History: Injury to right eye six weeks before; for past two weeks in another hospital without result. Examination: Central deep ulcer of cornea, 2.5 x 3.5 mm. in size, with points of undermining and with special infiltration at its lower margin; other corneal tissue fairly clear; conjunctival and iritic reaction characteristic; hypopyon 3.5 mm. deep; iris partly dilated; several small synechiæ; pupillary space hazy; vision, fingers at three feet. Treatment and course: On admission, numerous incisions of ulcer with perforation; carbolic and alcohol cauterization; 5000 units of antidiphtheritic serum hypodermically. In forty-eight hours the hypopyon was reduced and pain relieved. On July 8th, 11th, and 12th, 2000 units were injected each

day, the ulcer rapidly healing; hypopyon disappeared on July 17th. Discharged July 24, 1917.

Remarks.—Surgical and local treatment alone may account for result obtained in this case. In hospital eighteen days; 11,000 units injected.

CASE (A) VII.—Mary C., aged forty-two years. Indolent ulcer with hypopyon. Admitted to New York Eye and Ear Infirmary May 3, 1918. History: Had been treated in the clinic from February 1st to March 1st without success. At her visits to the hospital March 1st to 25th hypopyon was present, and trichloracetic acid (10 per cent.) was applied with good, but only temporary, result. She now returns to hospital worse than before. Examination: Central, fairly deep, indolent ulcer of cornea, 3 x 3 mm. in size, with no undermined margins and no marked areas of infiltration, the other corneal tissue being diffusely hazy, with loss of luster; conjunctival and iritic reaction only moderate in intensity; hypopyon 3 mm. deep; pupillary space a trifle cloudy; vision, fingers at six feet. Staphylococci found in smear. Wassermann reaction negative. Treatment and course: Intensive local treatment, including cauterization, produced no improvement, and on May 10th, seven days after admission, the ulcer was cauterized with carbolic acid (concentrated) and alcohol (45 per cent.), and 1000 units of antidiphtheritic serum injected. In twenty-four hours pain was relieved, and in forty-eight hours hypopyon appeared to be absorbing. Injection of 1000 units was repeated on May 13th, 17th, and 22d, and the hypopyon gradually disappeared by May 17th. Healing of the ulcer was complete July 25th and there was no return. Vision, 20/30.

Remarks.—The long duration of previous treatment with apparent response to a systemic influence, when the serum was injected, is at least significant of its effect. In hospital after first injection, fifteen days; 4000 units injected.

CASE (A) VIII.—A. B., aged fifty years. Hypopyon keratitis. Admitted to New York Eye and Ear Infirmary March 27, 1918. History: One week before, struck in right eye by small piece of iron. Examination: Central deep ulcer of cornea, 2 x 3 mm. in size, with points of undermined margins and points of infiltration, other corneal tissue being

fairly clear; conjunctival and iritic reaction characteristic; hypopyon 2.5 mm. deep; iris partly dilated from atropin; pupillary space fairly clear; vision, 10/200. Treatment and course: On admission, ulcer cauterized with bichlorid (1:500), and usual local treatment given. No improvement. Cautery repeated every other day. No improvement. On April 10th, hypopyon appeared to be increasing and ulcer more active. On April 12th, multiple incisions were made through base and margins of ulcer without penetration of cornea, and carbolic acid (concentrated) and alcohol (45 per cent.) used as cauterizing agent; 2000 units of antidiphtheritic serum were injected. Symptoms subsided in twenty-four hours, and rapid healing with disappearance of the hypopyon was noted in forty-eight to seventy-two hours after injection and cauterization. Injections were continued every second day, 1000 units at a dose, for three doses. There was no relapse; discharged April 26, 1918.

Remarks.—Here, simple cauterization was unable to check the progress of the ulcer, but the more highly caustic effect of carbolic acid may have been the determining factor. In hospital after first injection, fourteen days; 5000 units injected.

CASE (A) IX.—Mrs. T. B., aged fifty-eight years. Hypopyon keratitis. Admitted to New York Eye and Ear Infirmary May 13, 1918. History: Injury two weeks before. Examination: Large central kidney-shaped ulcer of cornea, 3 x 6 mm. in size, with undermined margins, other corneal tissue being diffusely infiltrated, especially at upper and lower margins of ulcer; conjunctival and iritic reaction intense; hypopyon 6 mm. deep; iris almost entirely obscured, as was the pupillary space; vision, shadows only. Treatment and course: On admission multiple incisions through base and into margins of the ulcer were made, with penetration of cornea, then cauterized with carbolic acid (concentrated) and alcohol (45 per cent.), and usual local treatment followed; 2000 units of antidiphtheritic serum injected. Symptoms were relieved in forty-eight hours; hypopyon only a line. One thousand units injected every three to four days for four doses. Rapid healing followed; discharged

May 24th, leukoma adherens remaining, but afterward operated and globe retained, with vision, fingers at eight feet.

Remarks.—Rapid progress after operation, cauterization, and injection, with preservation of globe. Commonly such an eye would come early to enucleation. In hospital eleven days; 6000 units injected.

CASE (A) X.—A. B., aged fifty-five years. Hypopyon keratitis. Admitted to New York Eye and Ear Infirmary June 18, 1918. History: Twenty-five years previously right eye lost by injury. Five days before several pieces of coal flew into left eye. Examination: Four deep central ulcers of cornea, one large and directly over pupillary area, 2 x 2.5 mm. in size, and three others, each about 1 x 1.5 mm. in size, located about the more central one, all active and with areas of infiltration about them, other corneal tissue being diffusely hazy; conjunctival and iritic injection intense; hypopyon 2 mm. deep; iris almost obscured, as was also the pupillary space; vision, fingers at one foot. Pneumococcus was found in smear. Treatment and course: On admission, cauterization with trichloracetic acid (10 per cent.), usual local treatment, and 2000 units antidiphtheritic serum injected. Pain continued, also hypopyon remained. June 20th, 1000 units injected, and on June 22d, pain relieved and hypopyon diminished, 1000 units were repeated. On June 23d hypopyon disappeared. On June 26th hypopyon returned and increased decidedly during the following day. On June 28th 2000 units injected, and on June 30th hypopyon had disappeared. This performance was repeated four times during the course of his treatment, which lasted until July 29th, when he was discharged. Four times the hypopyon returned under lapse of the serum treatment, and disappeared completely in twenty-four to forty-eight hours, with the injection of 2000 units of the serum. Vision, 10/200, and much improved by optical iridectomy.

Remarks.—This case, together with two or three others that I have observed, has done more to shake my conviction in the necessity of the specificity of passive immunity than anything else. Such an eye as this frequently going on to uncontrolled collapse and enucleation, not only did not perforate, though on the verge of it, cauterized mildly for

fear of perforation, and treated locally in the usual manner, but with serum often repeated in small doses, recovered gradually, and obtained sufficient vision with which this man may get about. In hospital one month, eleven days; 12,000 units injected.

CASE (A) XI.—J. F., aged thirty-one years. Hypopyon keratitis. Admitted to New York Eye and Ear Infirmary June 29, 1918. History: One week before a fine piece of steel flew into right eye. This eye has been exposed since childhood, when he received a severe burn of face and lids of right side. Examination: Central deep ulcer of cornea, 3.5 x 3.5 mm., with undermined margins and area of infiltration well marked, especially at the lower or dependent portion; other corneal tissue being diffusely hazy, partly from present involvement and partly from previous exposure, due to a marked eversion of the upper lid as result of old injury; conjunctival and iritic reaction intense; anterior chamber shallow, partly collapsed, and one-third filled with hypopyon; pupillary space could not be made out; vision, shadows only. Pneumococcus was found in the smear. Treatment and course: On admission, numerous incisions through base and margins of ulcer made in usual manner, and large portion of hypopyon evacuated; ulcer cauterized with carbolic acid (concentrated) and alcohol (45 per cent.); regular local treatment administered, and 2000 units antidiphtheritic serum injected, followed three days later by 1000 units. The eye quieted with unusual rapidity, and he was discharged July 17, 1918. Subsequent iridectomy for leukoma adherens yielded 10/200 vision.

Remarks.—Rapid recovery is unusual in such a severe type of case. In hospital eighteen days; 3000 units injected.

CASE (A) XII.—T. C., aged forty-six years. Hypopyon keratitis. Admitted to New York Eye and Ear Infirmary July 19, 1918. History: Five days previously foreign body cornea, left eye. Examination: Central deep ulcer of cornea, 1.5 x 2 mm. in size, with no undermining of margins, but a deep broad area of infiltration about the whole ulcer; conjunctival and iritic reaction characteristic; hypopyon 2 mm. deep; pupillary space fairly clear; vision, 20/200. Pneumococcus was found in smear. Treatment and course: On

admission, several incisions into base and margins of ulcer made without perforation; carbolic and alcohol cauterization, usual local treatment, and 2000 units antidiphtheritic serum injected. In forty-eight hours all pain relieved; pupil widely dilated; the hypopyon disappeared, and corneal tissue, which before was deeply infiltrated with the infectious process, was now clear and transparent. July 24th, 1000 units injected. Eye quiet and reaction almost negative on August 2d. Uneventful recovery; vision, 20/20.

Remarks.—Early treatment gave prompt response with satisfactory result in a situation not at all promising. This case appeared to show effects of serum treatment. In hospital fourteen days; 3000 units injected.

CASE (A) XIII.—Miss L. G., aged fourteen years. Hypopyon keratitis. Admitted to New York Eye and Ear Infirmary July 22, 1918. History: Six days before button from a machine struck left eye. Examination: Central deep ulcer of cornea, 2 x 2.5 mm. in size, with no undermining, but an area of deep infiltration surrounding it; the remaining cornea was fairly clear and transparent; conjunctival and iritic reaction intense; hypopyon 3 mm. deep; iris contracted to a small pupil; pupillary space hazy; vision, 5 200. Pneumococcus was found in smear. Treatment and course: On admission, ulcer was cureted, cauterized with carbolic and alcohol, usual local treatment, and 1000 units of antidiphtheritic serum were injected. Following day pain relieved, pupil dilated, reaction reduced, hypopyon apparently absorbing. July 26th, 1000 units of serum injected, and in forty-eight hours hypopyon had disappeared, eye quieting. August 2d, some return of pain and hypopyon, 0.5 to 1 mm., present; more reaction; 1000 units injected. August 3d, twenty-four hours later, hypopyon disappeared and relief of pain. August 5th, hypopyon returned; 1000 units injected. In twenty-four hours hypopyon again disappeared, but returned again in twenty-four hours. August 7th, 500 units ordered every other day, when disappearance of hypopyon was maintained with a moderate iritic and conjunctival reaction; no pain. On August 20th, anterior chamber collapsed and small hypopyon returned. The regular dose of 500 units was injected, and hypopyon disappeared

in twenty-four hours, and the serum was continued every other day until August 31st. No return of hypopyon occurred; the ulcer healed by September 3d, without any spreading of ulceration from its original site or further destruction of corneal tissue. A small iris attachment remained; eye quieted and patient discharged September 12, 1918. Subsequent iridectomy and tattooing were made; vision, 20/200.

Remarks.—A striking example of a combat between tissue forces and those of the infecting organism. In hospital one month twelve days; 8000 units injected.

CASE (A) XIV.—J. P., aged thirty-nine years. Hypopyon keratitis. Admitted to New York Eye and Ear Infirmary September 11, 1918. History: On August 26th, sixteen days before, struck in right eye by a piece of asbestos. During last ten days condition so much worse that he was advised to have the eye removed. Examination: Large ulceration extending over the nasal four-fifths of cornea, with deep active and undermining area occupying the lower nasal quadrant; other corneal tissue hazy with infiltration; conjunctival and iritic injection intense; hypopyon, 3 mm.; iris dilated and attached to lens-capsule; pupillary space filled with exudate; vision, shadows only. Excruciating pain. Treatment and course: On admission, multiple incisions through base and margins of ulcer, cauterized with carbolic and alcohol, with slight perforation, but no collapse of anterior chamber; usual local treatment, and 2000 units antidiphtheritic serum injected. In forty-eight hours pain was relieved, but hypopyon 1 mm. remained; pupil contracted; reaction same. September 13th, 2000 units injected, and in forty-eight hours some improvement was evident; hypopyon reduced to a line. September 18th, hypopyon increased to 2 mm., 2000 units injected. In forty-eight hours hypopyon reduced to a line; pupil remained contracted. September 22d, Wassermann made, and 2000 units of serum injected. September 24th, hypopyon reduced but no other improvement; Wassermann report was 4 plus. Intensive antisyphilitic treatment was begun, and hypopyon disappeared in twenty-four hours, not to return; rapid repair of cornea taking place. Eye quieted by October 9th, with-

out anterior synechia; cornea cleared remarkably, and vision of 20/200 obtained. Discharged October 12, 1918.

Remarks.—Can one attribute any effect to the serum in such a case, so severe, with definite response of hypopyon to injections and most satisfactory result? In hospital one month; 8000 units injected.

CASE (A) XV.—Wm. R., aged thirty-two years. Abscess of cornea with hypopyon. Admitted to New York Eye and Ear Infirmary October 12, 1918. History: One month before piece of steel struck left eye, and subsequent treatment failed to relieve him. During past week great pain and loss of vision, and eye more acutely inflamed than before. Examination: Central abscess of cornea, 2 x 2 mm. in size, with point of opening at its lower margin, other corneal tissue being diffusely hazy and without luster; conjunctival and iritic reaction intense, with considerable chemosis; hypopyon, 1.5 mm. deep; iris partly dilated from previous treatment; pupillary space fairly clear; vision, 3/200. Infecting organism was not determined. Treatment and course: On admission, an incision was made in lower margin of abscess and most of purulent substance evacuated without perforation; lips of wound cauterized with carbolic and alcohol; regular local treatment, 2000 units antidiphtheritic serum injected. In twenty-four hours pain was relieved and haziness of cornea greatly reduced. In forty-eight hours hypopyon had disappeared and pupil widely dilated. October 16th, 1000 units injected. Uneventful recovery, eye quieting October 18th; discharged October 22d; ultimately vision 20/30.

Remarks.—Local and surgical treatment may have been the only curative measures, but here again the rapid clearing and cleaning of the infected area point to a systemic influence. In hospital ten days; 3000 units injected.

CASE (A) XVI.—H. K., aged forty-four years. Hypopyon keratitis. Admitted to New York Eye and Ear Infirmary December 6, 1918. History: Four days before piece of wood struck right eye. Examination: Central and slightly temporal deep ulcer of cornea, 2 x 2.5 mm. in size, with points of undermining and deep area of infiltration about it; other corneal tissue fairly clear; conjunctival and iritic reaction

characteristic: hypopyon 2 mm. deep; iris contracted to a small pupil; pupillary space hazy; vision, 5 200. Treatment and course: On admission, multiple incisions through base and margins of ulcer without collapse of anterior chamber; cauterized with carbolic and alcohol; usual local treatment, 2000 units antidiphtheritic serum injected. In forty-eight hours hypopyon disappeared, no pain, reaction less, pupil dilated. December 10th, 1000 units injected and improvement followed. December 13th, line of hypopyon present, and 1000 units of serum injected. In twenty-four hours hypopyon disappeared not to return; rapid healing and clearing away of débris of ulcer; discharged December 23d; vision ultimately 20/30.

Remarks.—Recent injury, prompt treatment, satisfactory result. Local treatment may account for entire course of this case, but the reappearance of hypopyon and disappearance with the last serum injection and same local treatment are significant. In hospital sixteen days; 4000 units injected.

CASE (A) XVII.—F. K., aged fifty-three years. Hypopyon keratitis. Admitted to New York Eye and Ear Infirmary December 30, 1918. History: One week before left eye became painful following mild injury from foreign body. No previous illness. Examination: Central ulcer of cornea, 2 x 2 mm. in size, with slight undermining but extensive infiltration of cornea, other corneal tissue being diffusely and markedly hazy; conjunctival and iritic reaction intense; hypopyon 2 mm. deep; aqueous cloudy; iris dilated, irregularly thickened, and discolored; pupillary space contained film of exudate; vision, fingers at two feet. Treatment and course: On admission, multiple incisions through base and margins of ulcer, without perforation, cauterized with carbolic and alcohol, usual local treatment; 2000 units of antidiphtheritic serum injected. Condition remained unimproved until January 3d, four days after injection, when Wassermann was made and found to be 4 plus. Vigorous antisyphilitic treatment was then begun. Hypopyon remained; reaction continued until January 24th, when the eye became quiet, hypopyon disappeared; discharged January 31, 1919.

Remarks.—No effect upon hypopyon following injection

of serum. May this have been due to another element (syphilitic), present in this hypopyon, besides that of a pyogenic infection? In hospital one month; 2000 units injected.

CASE (A) XVIII.—Mrs. S. H., aged sixty-three years. Hypopyon keratitis. Admitted to New York Eye and Ear Infirmary January 27, 1919. History: Two weeks before foreign body in right eye. Examination: Central deep ulcer of cornea, 3 x 4 mm. in size, with no undermining but a broad area of infiltration about it; other portions of cornea diffusely hazy; conjunctival and iritic reaction intense; hypopyon 4 mm. deep; iris moderately dilated; pupillary space cloudy; intense pain; vision, hand movements. Pneumococcus and Klebs-Loeffler bacillus cultivated from ulcer. Treatment and course: On admission, application of bichlorid (1:500) and usual local treatment, but no cauterization or incision made; 2000 units antidiphtheritic serum injected. In forty-eight hours there was definite improvement; pain relieved, and February 2d hypopyon disappeared, ulcer healing. February 4th, hypopyon 1 mm. deep returned; 1000 units of serum injected. February 6th, hypopyon disappeared. February 7th, slight hypopyon returned; 1000 units injected. February 10th, hypopyon disappeared not to return; ulcer healed rapidly; eye quiet February 18th.

Remarks.—Here local treatment was mild, without incision or severe cautery measures; hypopyon returning with lapse of serum treatment and as promptly disappearing on injection, making the acceptance of a systemic serum effect quite definite. In hospital twenty-two days; 4000 units injected.

CASE (A) XIX.—S. S., aged fifty-three years. Hypopyon keratitis. Admitted to New York Eye and Ear Infirmary February 11, 1919. History: Foreign body of cornea four days before. Examination: Central deep ulcer of cornea, 1 x 2 mm. in size, with undermined margin below and deep infiltration at several points, rest of cornea fairly clear; reaction intense; hypopyon, 0.5 mm.; iris contracted and with several points of attachment; pupillary space clear; vision, 10/200; pain violent. Cultivation from ulcer showed the pneumococcus. Treatment and course: On admission,

cauterized ulcer with bichlorid (1:500) by prolonged application; usual local treatment; 2000 units antidiphtheritic serum injected. In twenty-four hours no pain, and 1000 units of serum injected. February 13th no hypopyon; iris widely dilated; less reaction; 1000 units injected. February 14th, eye quieting, ulcer clearing, no infiltrated area remains. Discharged February 17th, six days after admission.

Remarks.—Another example of rapid response to early treatment, the result attributed to local treatment only (?). In hospital six days; 4000 units injected.

CASE (A) XX.—J. W., aged fifty-two years. Hypopyon keratitis. Admitted to New York Eye and Ear Infirmary February 16, 1919. History: Two weeks before foreign body in right eye; appeared in clinic seven days afterward, when hypopyon was 3 mm. deep, and he refused to be admitted. Examination: Central deep ulcer of cornea, 2 x 2 mm., with deep infiltration about it, entire cornea being so hazy the iris could not be made out; conjunctival and iritic injection intense; hypopyon 5 mm. deep, pupillary space not visible; vision, shadows only. Pneumococcus. Treatment and course: On admission, multiple incisions made through ulcer without perforation; cauterized with carbolic acid and alcohol; usual local treatment, and 2000 units of serum injected. Following day hypopyon reduced and cornea clearing. February 18th improvement more marked, 1000 units injected, and repeated every day for three doses. Rapid absorption of hypopyon and clearing of the ulcer followed; no hypopyon remained by February 24th, and he was discharged March 4, 1919.

Remarks.—Local treatment undoubtedly important factor, but rapidity of repair, etc., is significant of serum effect. Time in hospital, sixteen days; 5000 units injected.

CASE (A) XXI.—R. R., aged sixty-five years. Abscess of cornea, hypopyon. Admitted to New York Eye and Ear Infirmary February 17, 1919. History: One week before foreign body cornea. Examination: Large central abscess of cornea, 5 x 5 mm., rest of cornea very hazy; conjunctival and iritic injection intense; hypopyon almost fills the anterior chamber; vision, shadows only. Pneumococcus. On admission, abscess incised, evacuated, and cauterized with

carbolic acid and alcohol, perforation taking place. Usual local treatment; 2000 units of serum injected and 1000 units every day for three doses, and again repeated on February 24th. On February 27th, 500 units injected. There was rapid repair and clearing away of ulcer débris, the area of destruction being unusually large; discharged March 21, 1919.

Remarks.—Character and rapidity of repair, with preservation of the globe, were unexpected. In hospital one month four days; 6500 units injected.

CASE (A) XXII.—J. S., aged six years. Pustule of cornea (phlyctenular), hypopyon. Admitted to New York Eye and Ear Infirmary February 21, 1919. Phlyctenular conjunctivitis for past month. Examination: Usual type of severe involvement of phlyctenular pustule. On admission, the usual catharsis and feeding and local hot bathing; atropin and argyrol administered until March 15th, three weeks after admission, when a line of hypopyon appeared. On March 16th, 2 mm. of hypopyon, corneal process and reaction increased. Without any change in the local or general treatment and without any surgical interference or cautery, 1000 units of serum were injected. In twelve hours hypopyon had completely disappeared, conjunctival and corneal reaction improved; in forty-eight hours the eye was almost entirely quiet, and three days afterward she was discharged, the eye being open and only slightly injected March 22, 1919.

Remarks.—Here undoubtedly a systemic influence is the cause of the pustule with hypopyon, promptly met by the systemic effect of the serum. In hospital five days after injection; 1000 units injected.

CASE (A) XXIII.—S. R., aged sixty-four years. Hypopyon keratitis. Admitted to New York Eye and Ear Infirmary February 28, 1919. History: Thirteen days before struck in right eye by a piece of stone. Examination: Central deep ulcer, 3 x 2 mm., with undermined margins and deep corneal infiltration, rest of cornea hazy; hypopyon 2 mm. deep; conjunctival and iritic injection marked; iris contracted; pupillary space hazy; vision, fingers at three feet; intense pain. Pneumococcus. On admission, regular

local treatment administered, but no cauterization and no serum because of slight temperature. But slight increase of hypopyon noted on March 3d, when 2000 units of serum injected. Rise of temperature followed, and in twenty-four hours hypopyon disappeared and pain relieved. March 4th and 5th, 1000 units injected; no hypopyon. On March 8th hypopyon returned, also return of pain, and 1000 units injected. March 9th and 10th hypopyon remained, some pain, and on March 11th, 1000 units injected. March 13th hypopyon same, 1000 units injected, and on March 14th hypopyon diminished, and by March 16th disappeared not to return. Discharged March 24, 1919.

Remarks.—Return of hypopyon and its disappearance with serum treatment are highly significant of its effect. In hospital nearly one month; 7000 units injected.

CASE (B) I.—T. C., aged fifty-three years. Penetrating wound of cornea, iris prolapsed, hypopyon. Admitted to New York Eye and Ear Infirmary February 3, 1919. History: Day before piece of wood struck right eye. Examination: Penetrating wound at nasal limbus; iris prolapsed; no hypopyon; usual conjunctival and iritic reaction; lens opaque in nasal half; cornea clear; vision, fingers at three feet. Treatment and course: Iridectomy made on February 4th. In forty-eight hours, February 6th, hypopyon appeared. On the following day it was 1.5 to 2 mm. deep; lips of wound appeared infected, but a blood culture failed to give any organism but the Klebs-Loeffler bacillus, and 2000 units of antidiphtheritic serum were injected. In forty-eight hours, February 9th, hypopyon disappeared and did not return; pain relieved; eye quieted; discharged February 10, 1919. Subsequent cataract extraction should yield normal vision.

Remarks.—Disappearance of the hypopyon may have been a coincidence—may have been in the beginning the result of traumatic iritis, but nevertheless it progressed in twenty-four hours from February 6th to February 7th, and promptly disappeared with the injection of the serum. The local treatment here cannot be regarded as of any importance, being the same before and after injection. Time in hospital after injection was three days; 2000 units injected.

CASE (B) II.—Miss R. M., aged fifteen years. Penetrat-

ing wound (infection). Admitted to New York Eye and Ear Infirmary October 7, 1918. History: Previous day, struck in left eye by a nail shot from rubber band. Examination: Lids swollen and greatly inflamed; cornea ruptured at nasal side of pupillary area; conjunctival and iritic reaction intense; hypopyon 1 mm. deep; iris irregularly dilated and incarcerated in wound; pupillary space fairly clear; vision, 20/40. Treatment and course: On admission, the usual local treatment was administered, and 2000 units of antidiphtheritic serum injected. Following day, reaction more violent, lids more edematous and inflamed. October 9th, 1000 units injected, and in forty-eight hours cornea appeared to be clearing, hypopyon unchanged, reaction same, but no pain. October 12th, 1000 units of serum injected. No change until October 15th, when, over night, anterior chamber became half filled with purulent exudate. October 16th, 1000 units injected. In forty-eight hours eye was more quiet, but exudate remained. October 18th iridectomy and irrigation of anterior chamber made by Dr. W. E. Lambert. A rather violent reaction followed, but rapidly quieted; some remaining hypopyon disappeared, and patient discharged November 6th. Subsequently, November 19th, removal of the lens was made without event, and the eye became quiet, cornea clear and transparent, the iris a natural blue color; vision with sph. $+12.00 \supset$ cyl. $+1.50$ ax. $15° = 20/50$.

Remarks.—Is this the usual course of a penetrating wound with infection of the anterior chamber? In hospital one month; 5000 units injected.

CASE (C) I.—J. L., aged twenty-eight years. Penetrating wound of cornea, traumatic cataract, infection (panophthalmitis). Admitted to New York Eye and Ear Infirmary May 15, 1918. History: Ten days before piece of steel two inches long struck right eye, and patient withdrew steel from eye. Examination: Lids greatly swollen and edematous; small central penetrating wound; cornea diffusely hazy; anterior chamber very deep and contained hyphema and hypopyon 3 mm. deep; intense conjunctival and iritic reaction with some chemosis; iris contracted and bound to lens capsule; pupillary space occluded; vision, light per-

ception only. Treatment and course: Atropin and hot applications gave no relief; pain excruciating, and on May 22d, eight days after admission, 2000 units antidiphtheritic serum injected. In forty-eight hours pain greatly relieved, but not entirely; hypopyon reduced. May 27th, 1000 unit injected; pain entirely relieved, and hypopyon almost disappeared. May 29th, 1000 units injected. Conjunctival and iritic reaction continued; occlusio and seclusio pupillæ. June 7th to 14th, eye almost entirely quiet, and to such a degree that iridectomy was decided upon. Three days after iridectomy intense pain returned and purulent exudate partly filled anterior chamber. Two thousand units of serum were of no avail, and the eye was enucleated June 21, 1918.

Remarks.—Although final destruction of the globe took place, can the serum effect be ruled out, since pain was primarily relieved following its injection, and the purulent iritis and abscess of the vitreous in the first stage were rendered quiescent by what influence, low virulent organism, or systemic resistance? It must have been a virulent organism to have caused such violent primary symptoms, and when stirred by the iridectomy, again took on a virulent phase. In hospital until eye quieted sufficient for iridectomy which was three to four weeks; 5000 units injected.

CASE (C) II.—S. B., aged thirty-three years. Penetrating wound, steel in vitreous, infection (panophthalmitis). Admitted to New York Eye and Ear Infirmary June 27, 1918. History: Day before, piece of steel struck left eye. *X*-ray localized large steel particle, 1.5 x 4 mm., in nasal side of vitreous chamber just beyond point of entrance. Magnet extraction through original wound June 28th. July 1st, edema of lids, marked chemosis, cornea hazy, 2.5 mm. hypopyon, pupillary space hazy, intense pain. Treatment and course: July 4th, 2000 units antidiphtheritic serum injected; constant ice compresses; atropin. July 5th, pain entirely relieved; no progress in reaction or hypopyon. July 6th, less chemosis, 1000 units injected. July 7th, less chemosis and lid reaction, no pain, hypopyon absorbing. July 9th, exudate present in pupillary space, less chemosis; 1000 units of serum injected. July 12th, less general reaction, cornea clearing, no pain. July 19th, 1000 units injected. July 26th,

lid and general reaction much improved, no pain; 1000 units injected. June 31st, enucleation.

Remarks.—Instead of the intense pain, persistent swelling and acute reaction with corneal destruction and bursting forth of the abscess of the vitreous, as is commonly the case, there was a gradual, fairly rapid, subsiding of the acute reaction from the very beginning of the panophthalmitis; absolute relief of pain, the eye becoming so quiet in a reasonable time that enucleation was regarded as being safe under such conditions. In hospital one month; 6000 units injected.

CASE (C) III.—T. L., aged thirty-four years. Penetrating wound, steel in vitreous, infection (panophthalmitis). Admitted to New York Eye and Ear Infirmary August 17, 1918. History: Same day piece of steel instrument flew into left eye. Steel particle, 2 x 4 mm., located by *x*-ray in vitreous at nasal side of lens; entangled in iris torn from its roots just beyond point of entrance through cornea. Magnet extraction of steel through original wound of entrance on day of admission. Two days after operation, August 19th, intense pain; swelling and inflammation of the lids; marked chemosis of conjunctiva; iritic reaction great; cornea diffusely hazy; hypopyon, 2 mm.; pupillary space covered by film of exudate; vision, light only. Pneumococcus found in smear. Treatment and course: August 19th, 2000 units antidiphtheritic serum injected, and constant ice compresses administered. Following day pain somewhat relieved, but conjunctival and iritic reaction more violent; cornea more densely hazy than before; anterior chamber almost completely filled with purulent exudate. August 21st, pain entirely disappeared, otherwise condition unchanged; 1000 units of serum injected. August 24th, chemosis was reduced, hypopyon absorbing, cornea clearing, lids much improved, iritic reaction less, no pain. August 27th, improvement more marked in every way, 1000 units injected. September 3d, cornea almost entirely clear and transparent, hypopyon nearly disappeared, reaction less, no pain. September 6th, organized exudate fills pupillary space, but no hypopyon, no pain. September 8th, 1000 units of serum injected. September 13th, eye quieted, shrinking, and soft; slight

iritic injection. September 18th, enucleation with only moderate reaction following.

Remarks.—Is this the usual course of panophthalmitis? No pain after the third day, all reaction subsiding. In hospital one month; 5000 units injected.

CASE (C) IV.—M. P., aged forty-nine years. Penetrating wound of cornea, traumatic cataract (panophthalmitis). Admitted to New York Eye and Ear Infirmary February 2, 1919. History: Two weeks before struck in right eye by piece of wood. Eye has been inflamed and painful, but during past two days unbearably so. Examination: Lids swollen; conjunctiva greatly injected and chemotic; abundant mucopurulent discharge; iritic reaction violent; cornea hazy; hypopyon 2 mm.; iris discolored and bound to lens capsule; pupillary space filled with exudate; lens cataractous; vision, shadows; excruciating pain. Bacillus subtilis found in conjunctival smear. *X*-ray negative. Treatment and course: Constant ice compresses; argyrol, 25 per cent., t.i.d. Two thousand units antidiphtheritic serum injected. No change on following day. February 5th, pain greatly reduced; 1000 units injected. February 7th, no pain; lids less edematous; less conjunctival reaction; cornea clearing, hypopyon same; pupillary space more densely filled with exudate; iris retracted to form deep anterior chamber. February 8th, eye quieting, 1000 units of serum injected. February 12th, 1000 units injected. February 14th, iritic reaction mild. February 15th, enucleation with moderate reaction. Cultivation from the interior of globe showed bacillus subtilis, staphylococci, and pneumococci.

Remarks.—Relief of pain and moderation of symptoms and reaction in a reasonably short period of time point to a systemic effect. In hospital until enucleation, thirteen days; 5000 units injected.

CASE (D) I.—G. K., aged forty-two years. Serpiginous ulcer of cornea. Admitted to New York Eye and Ear Infirmary February 16, 1919. History: Foreign body on right cornea four days before; left eye enucleated ten years ago. Examination: Central deep ulcer of cornea, 1 x 2 mm. in size, directly over the pupillary area; serpiginous in appearance, with undermining of the margin at one point and beginning deep

infiltration about entire ulcer; other corneal tissue fairly clear and transparent; conjunctival and iritic reaction characteristic of a virulent infection; no hypopyon, but aqueous a trifle hazy; iris contracted to small pupil; pupillary space clear; vision, 20/50; moderate pain. Treatment and course: On admission, ulcer cauterized by prolonged application of bichlorid (1:500), usual local treatment; 2000 units antidiphtheritic serum injected. Rapid healing and clearing of cornea were evident in forty-eight hours; no hypopyon appeared, and patient was discharged February 23d; vision, 20/20.

Remarks.—Serpiginous type of ulcer in the only eye; treated with antidiphtheritic serum as precautionary, though the result may have been due entirely to local treatment In hospital seven days; 2000 units injected.

ANALYSIS OF CASES.—In making an analysis of the cases reported above I have striven to compile the data of all of them from the standpoint of the history, examination, serum treatment, other treatment, course, symptomatic effect, and results, attempting to focus all the cases upon each point of consideration, so that a full understanding and appreciation of the effect, if any, of the serum can be studied and conclusions drawn in a clear and unbiased manner.

The first group of cases, hypopyon keratitis, 23 in number, are sufficiently varied in degree of severity and in extent of involvement, and are reported in sufficient detail to bear a close analysis. It is kept in mind, while studying each case, that the factors of systemic effect upon the local condition are of more real significance than those of purely local effects, but it is obviously a difficult task to judge in many instances whether the serum has had any effect, and if so, in what degree.

Of the 23 cases of hypopyon keratitis, 18 were over forty years of age, 13 of these over fifty years. Five cases were under forty years of age, and three of these were over thirty. Of the five under forty years of age, four had systemic or

local conditions which influenced the vitality of the cornea. Case XI, thirty-one years, had an exposed cornea since childhood, when his face and lids were severely burned; Case XIV, thirty-nine years, had a 4 plus Wassermann; Case XV, thirty-two years, had a neglected injury of a month's standing; and Case XXII was of a phlyctenular diathesis. The only clear-cut case in which lowered corneal resistance cannot be accounted for was that of Case XIII, fourteen years of age, and in this case there was no increase in corneal destruction, though present over a period of one month and twelve days in the hospital. This bears out the usual history of these cases, for it is well known that hypopyon keratitis is much more common in the aged and among debilitated individuals, following upon the neglect of a local injury. In all the cases but one a local injury was admitted, and this originated from a pustule of phlyctenular keratitis, Case XXII. The period of involvement previous to admission to the hospital varied as follows: 10 in less than a week, 4 in one week, 4 in two weeks, 3 in three weeks, and 5 in more than three weeks' time.

If one studies the processes of ulceration in these cases, it is noticed that the center or near center of the cornea is involved in every case, this being the area least protected by systemic resistance, furthest from the source of nourishment (the blood). All the cases had a deep involvement of the cornea, which type usually of itself is capable of producing hypopyon. The ulcers varied greatly in size from 1.5x2 mm. to that of three-quarters of the entire corneal surface. The majority of cases had an undermining of the margins of the ulcer and a peri-ulcerative zone of infiltration, characterizing the severity and progress of the infection in the individual case. This was also true of the conjunctival and iritic reaction, and in 6 cases definite iritic involvement complicated the hypopyon keratitis, Cases II, III, VI, XIV, XVII, and XXI. Depth of hypopyon varied from a mere line to 6 mm., the

majority being about 2 mm. deep. The pneumococcus was the prevailing organism in almost every case; in one case (VII) the staphylococcus was found to be the infecting germ; in several cases no organism was isolated, or cultures failed to be made. Two cases (XIV and XVII) were complicated by syphilis.

As for treatment, similar local treatment was employed in all the cases; hot fomentations of boric acid solution, where there was little danger of perforation, hot salt solution irrigations where perforation was present or imminent, bichlorid vaselin (1:5000), atropin, a dressing and bandage. The cautery employed was in every case chemical, bichlorid (1:500) in less critical cases, and carbolic acid in those more progressive and destructive in character. Bichlorid was used in five cases, carbolic acid in 16. Instead of the Saemisch transfixion, multiple incisions through the base and margins of the ulcer were made, sometimes perforation taking place with part or complete evacuation of the aqueous and hypopyon, really amounting to a Saemisch, though in the majority of instances perforation did not take place, no attempt, however, being made to prevent it at this time. These incisions were made according to the method of Verhoeff in opening up an ulcerated area. With a fine Lagrange knife, the blade held with the cutting-edge forward, the tissue is divided by a forward and upward movement of the knife, each incision passing through the margin and base of the ulcer. This was performed in 16 cases, 4 of which perforated at the time of operation. Serum treatment was administered early—within four days in 6 cases, within one week to ten days in 6 cases, within two weeks or more in 11 cases. The dose varied with the severity and extent of the infection in the individual case, larger doses being given in the first 6 cases for one or two doses, smaller doses being used in the last 17 cases, but given more frequently. The largest single dose was 5000 units, repeated in three days.

The smallest single dose was 500 units, repeated every other day for several days, and which seemed to be effectual (Case VIII). The average dose, and one most often employed, was that of 2000 units, followed every other day by 1000 units for four doses or less, as the case demanded. The interval between doses varied from every other day to a week; in one case (XVIII) eight days intervened, and in another case (XIV) seventeen days intervened. The number of injections depended usually upon the size of the dose and the chronicity of the involvement. One injection was sufficient in one case (XXII), 12 injections were necessary in another case (XIII), three or four injections being the average number required in the majority of the cases. The amount of serum given in a single case varied greatly, ranging from 2000 to 11,000 units.

Of the most importance, in this analysis, is the study and comparison of the course of events in these cases, following treatment as outlined above. The earliest time after injection, when the first change in the process of infection was noted, was twelve hours, when hypopyon of 1.5 mm. disappeared after an injection of 1000 units in Case XXII. The usual time intervening after an injection before a change could be noted was twenty-four hours, forty-eight hours almost invariably registering a well-marked improvement. Relief of symptoms, pain, conjunctival reaction, and iritic injection was constantly significant in forty-eight hours and sometimes in twenty-four hours following the initial serum injection. Hypopyon, promptly in twenty-four to forty-eight hours, was definitely reduced in amount or disappeared in all instances except Cases XIV and XVII, these being syphilitic. Hypopyon disappeared slowly in four cases only; of these, two were syphilitic (XIV and XVII) and two with deep hypopyon (VII and XVIII). Hypopyon persisted without regard to injection of the serum only in the two syphilitic cases, but on the administration of mixed

treatment rapidly disappeared. Hypopyon reappeared in seven cases, I, X, XIII, XIV, XVI, XVIII, XXIII, and disappeared promptly within twenty-four to forty-eight hours after injection of the serum in each case, except Case XIV, who was syphilitic, and this hypopyon yielded rapidly to mixed treatment. The iris was more or less involved in every case, but more decidedly so at the initial dose of serum in Cases II, III, VI, XIV, and XVII, and responded to the injection by dilatation, freeing of synechiæ, and reduced reaction, except in Cases XIV and XVII (syphilitics). As to the process of healing, I believe it is obvious that this was usually rapid, but more important still was the manner in which healing took place. There was noticed, not only in the less severe but the most severe cases, a rapid clearing away of ulcer débris, such as does not usually occur in these cases, and especially of note was the transparency of the remaining not yet healed corneal tissue, the ulcer itself taking on a clear and clean appearance early in the process of repair. In the most severe cases, with penetration and collapse of the anterior chamber, there was present in the ulcerated area a blood-suffused mass, which in forty-eight hours more was shedding débris from the process of repair. Time required for hospital care after injection varied greatly, of course, but was commonly from ten days to three weeks, the shortest time being four days (Case XXII) and the longest, five weeks (Cases X and XIII).

Now to summarize this analysis one must necessarily view the effects and relative results of this treatment. As to the rapidity of effect, it is hardly worth while to recall the many instances related above, except to point out Cases XIV and XVII, where there appeared to be little or no effect and where syphilis complicated. The result of a prompt healing and clearing away of ulcer débris left surprisingly mild opacities, and in many instances the vision obtained was far beyond expectations, as in Cases II, V, VII, XII,

XV, XVI, XIX, XXII, and XXIII. Those cases in which the usual treatment was administered over a long period of time and without result, and which responded promptly to injection of the serum, were Cases III, VI, VII, VIII, IX, X, XIII, XV, and XXII. Cases in which a definite relationship appears between injection and pathologic change and indicative of a pronounced systemic effect were I, II, III, IV, X, XII, XIII, XVI, XVIII, XXII, and XXIII.

Analysis of the second group of cases (B I and II), penetrating wound of the cornea with infection of anterior chamber, resolves itself into the following conclusions: The course and response to treatment, with preservation of the globe and useful vision obtained in each case, must be admitted to be quite contrary to the usual course of events in this type of case. I believe in Case B II that panophthalmitis was averted. Could it have been due to the serum therapy of 5000 units?

Analysis of the third group of cases (C I, II, III, IV), panophthalmitis, is of greater significance than it would seem at first glance. It was Aristotle who said: "That which is destroyed and can not be avoided ceases to be of interest." The mere presence of an abscess or purulent infection of the vitreous is sufficient in itself that the eye is beyond repair, and, therefore, the matter of vision and even preservation of the globe "ceases to be of interest." So far as the observation of the effects of antidiphtheritic serum upon the usual course and symptoms of the cases is concerned, it becomes a matter not only of interest, but one definitely expressive of the systemic effect of the serum upon an infectious process. While cure was not remotely anticipated, and not at any time was there any evidence of it, there was, on the other hand, evidence of curative properties in the serum, for in every case symptoms, both objective and subjective, subsided, and the infection rapidly became one of a quiet, mildly virulent type, entirely opposite to the usual

course of events. Because the serum did not cure the panophthalmitis, restore the globe, and give some vision, can it be ruled out and be regarded as having no curative properties? Roemer says: "Any one who regards the word serum as a miracle is suffering under an illusion!" And yet Axenfeld concludes in his experiments on rabbits that, since the eyes went on to panophthalmitis and the animals died after injections of pneumococci into the vitreous, the serum has no general or local effect.

The last case, D L., ulcus serpens, is reported in order to show that where every therapeutic means at our disposal is demanded of us and is employed, one may prevent a catastrophe.

Theory of Effect.—It seems to me unfortunate that the subject of paraspecific therapy has been too excitedly and unreservedly presented to the profession, and by men whose enthusiasm over what they observed clinically led them to herald the serum in the very beginning of its development as a "cure-all" of all infections, regardless of bacteriologic diagnosis. Reports of "remarkable cures" by Deutschmann and his followers made it worse, for many of them were based upon opposing fundamental principles of pathology and bacteriology, so that wholly unreasonable results and reports and theories have together made the real value of paraspecific therapy difficult of recognition. It must be remembered, however, that this therapy was not born of one man or two, but of a number, working along similar lines in different countries and with different products as a paraspecific agent, each wholly unaware for a time (1905 to 1907) that the same theory was being studied by his contemporary. Moreover, the whole theory of resistance and immunity during the past ten years has become more and more complicated, the more is learned about specificity, foreign proteins, activating elements of human serum, blood-cell energy, and the "kinetic" and other forces of internal secretion.

Is it a fair judgment to conclude from experiments on animals similarly infected that in man the serum is without value? And is it a fair conclusion, from purely clinical observations on cases in which intensive local treatment has also been employed, that the serum has real curative properties? This seems to me to be the crux of the situation, and leaves the question in the open, with more confusion than should be, until sufficiently reliable and carefully studied history and case reports are forthcoming. And is it not true that, early in the course of an ocular infection, and especially in hypopyon keratitis, the case is treated from the local standpoint too exclusively as a rule? It is astonishing how many complications (systemic) occur among these cases; for example, poor conditions of nourishment and environment, lack of proper systematic care, gastro-intestinal disturbances, dyscrasias, as well as cardiovascular, nephritic, tubercular, syphilitic conditions, etc. All the more, therefore, it seems to me, it behooves one to study the systemic factor in the individual case.

For these reasons and others it has occurred to me that if one first establishes the necessity of a systemic influence in hypopyon keratitis, for the moment disregarding the virulence of the infecting organism, and then can show that there is a curative response in the infectious process to a systemic influence (serum injection), one can logically deduce that there are curative properties in the serum against the infection. In support of the first premise, namely, that a systemic influence is present in hypopyon keratitis, I wish to record the following observations:

1. Age is commonly past middle life. 2. Environment is usually poor and one without care. 3. Type of the undernourished. 4. Majority show some form of debilitation. 5. Primary ulcer cases. 6. Phlyctenular pustule especially. 7. Center of cornea commonly the site of deep involvement furthest from source of nourishment. 8. Many disease compli-

cations—tuberculosis, syphilis, nephritis, dyscrasias, etc. 9. Many others commonly admitted.

In support of the second premise, that a curative response in the infectious process follows a systemic effect from serum injection, the following evidence is given:

1. Innumerable case reports from the literature show a definite response to injections of the serum as outlined above. 2. Check in progress of the infectious process in twenty-four hours after an injection, as noted in my series of cases. 3. Relief of symptoms, pain, conjunctival and iritic reaction, in twenty-four to forty-eight hours following a dose of the serum. 4. Prompt diminution or disappearance of hypopyon in twenty-four to forty-eight hours after injection in every case reported in my series except two (these syphilitic). 5. Hypopyon returned on lapse of serum treatment and as promptly disappeared on injection of serum, as reported in 7 cases, I, X, XIII, XIV, XVI, XVIII, and XXIII. 6. Iris attachments responded to the injection in all cases except the two cases of syphilis, which responded rapidly to mixed treatment. 7. Healing process and the manner of clearing away of ulcer débris, leaving transparent corneal substance early in the process of repair, almost as distinctly noticeable a factor as the disappearance of hypopyon. 8. Rapidity of effect must be accepted. 9. Nine cases, III, VI, VII, VIII, IX, X, XIII, XV, and XXII, gave response to injection immediately, although no change could be noted from previous long-continued treatment. 10. Unusual effect upon cases of penetrating wounds, and especially of purulent infection of the anterior chamber, Case B II. 11. The resistance and defense of the tissues against the infection, as demonstrated by the course and treatment of the four cases of panophthalmitis reported.

The conclusion necessarily follows that antidiphtheritic serum possesses curative properties against pneumococcic infections of the non-vascular (refractive) structures of the

eye. It is, of course, impossible to furnish absolute proof, nor do I propose that this conclusion is absolute, in so far as the serum being the cure is concerned, or in any way the whole cure of these infections. On the other hand, local treatment is just as essential as the serum treatment, but that the systemic factor always present in every serious ocular infection must be met by a serum or other treatment, as the case demands, is, to my reasoning, essential. In the two syphilitic cases cited above the effect of the serum showed definite limitations, even to no effect, until mixed treatment was administered, whereas in all the other cases improvement was noted following injection of the serum, intensive local treatment being employed. Furthermore, many of my series of cases, III, VI, VII, VIII, IX, X, XIII, XV, and XXII, showed definite and rapid improvement and cure, where, previous to the serum injection, long-continued local treatment had produced little or no effect. Case XXII especially is so indicative, particularly since this case had the accepted systemic disturbance of a phlyctenular conjunctivitis. Tuberculin had not been accepted as a valuable agent in ophthalmic therapeutics until recently, and it is not now regarded by bacteriologist or general practitioner as of much practical value in general medicine. In fact, the acceptance of its efficacy in ophthalmology now is based upon carefully studied clinical observations constantly repeated, and not at all upon experiments made on animals. Roemer's pneumococcic serum is admittedly bactericidal in effect and has curative properties, as Axenfeld admits, and yet R. Solm found no effect of the serum when experimenting on animals, while its effect in man was definitely curative. Is it to be expected, then, that in the face of clinical results with antidiphtheritic serum its apparent curative properties in man should be ruled out because of negative experimental results on animals? As for paraspecificity, it came when the theory of immunity

tended more and more to greater specificity, for the strains of pneumococci and meningococci, etc., act well against their particular strain of organism, one strain of the same organism being apparently ineffective or not as effective against another strain, so that the shock of non-specificity was more abrupt than it otherwise would have been, so narrow had become the one idea of specificity of strain against strain in both passive and active immunity. Antitetanic serum, because it was not sufficiently and definitely curative in its effect, threatened for a long time to be lost as one of the most valuable prophylactic agencies, when its real value was being put to the test through tireless experiments and clinical observations, because it did not meet the full bacteriologic and therapeutic laws required for a cure.

The theory of how antidiphtheritic serum effects are exerted against non-specific infections of the eye has been variously explained by the exponents of this therapy. Darier contends that strong toxins, such as antidiphtheritic or tetanus toxin, excite all the organs of the body to the production of antibodies of all kinds, not merely to the production of diphtheritic antitoxins, thus making the serum effective in all kinds of infection. It is well known that Loeffler first pointed out that the normal cornea shares in general bacterial immunity; Roemer has shown it to be true of pneumococci; and Ehrlich and Roemer proved it in regard to antitoxic immunity to toxin of diphtheria. It is also recognized, through the work of A. Leber, Roemer, Zur Nedden, and others, that receptors of the first order (antitoxins, agglutinins, and precipitins) pass in small quantities from the blood into the aqueous humor; on the other hand, receptors of the third order (bactericidal substances, opsonins, hemolysins, and cytotoxins), do not at all pass normally into the aqueous. The entrance of the latter into the aqueous has been proved after penetration or irritation by injection, or heating, or chemical effects, and particularly

in the presence of an inflammation. The vitreous is believed to share so slightly in any kind of immunity that, except under subconjunctival injections or violent inflammation, there is no evidence at all of the presence of immune bodies. Lawford states that immunity on the part of non-vascular structures of the eye has not been confirmed; that the immunity possessed by the aqueous and vitreous is almost negligible, and even by all known means of increasing this immunity it cannot be brought up to the blood-serum. He concludes that, with the exception of antidiphtheritic serum alone, therapeutic serum, either bactericidal or antitoxic, has been disappointing. He also points out that active immunization (vaccines) requires so much time that the process is not suited to an acute inflammation, although the immunity is more lasting. On the other hand, passive immunization (serums) has an effect that is immediate but transient. Is it not probable that since specific serums are known to act efficaciously in the vascular structures, and not with the constancy that paraspecific serums act upon non-vascular structures, there is a reason here in the anatomic structure that may be explanatory of a theory not yet understood to account for the therapeutic effect of antidiphtheritic serum upon non-specific infections of the refractive media. What is the change, anatomic, cellular, or chemical, that takes place in the cornea and aqueous and adjacent structures, and causes the absorption of hypopyon of 1.5 mm. deep in twenty-four hours after an injection of 2000 units of antidiphtheritic serum? The abrupt disappearance of hypopyon is one of the most unmistakable and distinctive changes that is noted in an infectious process affected by serum injection. Therefore to advance a theory that would satisfy this hypothesis should come reasonably near the solution of the effect of the serum. The composition of hypopyon is well known. In process of its formation it is believed to be an element of protection, defensive in the

course of the combat, and is always significant of danger of deeper involvement or progress of the infection. That its disappearance is due to and significant of improvement in the invading process should be reasonable ground, therefore, upon which to base a curative cause for the improvement. One must keep in mind that hypopyon may disappear spontaneously without treatment, in which case it is believed to be due to the natural forces of the tissues to overcome an enemy of weaker virulence. Again it may disappear under simple local stimulative measures, when it is concluded that the natural forces, by the aid of local treatment, checked the invasion of an infection more virulent than the natural forces of the tissues can alone combat. Also it may disappear after local stimulation and removal of the contents of the infected area or by cauterization of it, when it is reasonable to believe that these measures directly applied give the advantage to the natural forces of the tissues to overcome an infection whose virulence is far superior to the normal resistance of the particular individual. And so one observes that, by numerous means of increasing or stimulating the natural forces of defense, and by means of attacking the infection by direct removal or killing of the bacteria, or by weakening their virulence, hypopyon disappears and repair is forthcoming. The following questions now arise: (1) Does the serum increase the natural forces of resistance? (2) Is the serum bactericidal? (3) Does it weaken the virulence of the invading organism? That the serum does produce a vital resistance is quite reasonable and is the theory usually advocated. There is certain evidence that there is a systemic element in the cause and effect of hypopyon keratitis, and the injection produces rapid improvement in the process. Whether hyperactivity of all the organs and tissues of the body and the production of antibodies with non-specific properties constitute the full explanation, further experimentation and study must determine. It is quite possible that the "vital energy of the

tissues," so termed, may be another name for the foreign protein effect of the horse serum, regardless of the diphtheritic elements present. Piccaluga (Turin) refers to normal horse serum as possessing a hemolytic, agglutinating, and bactericidal action, as demonstrated by practical results and obtained by many experiments (Paton, Pes), and therefore concludes that in the horse there is a superproduction of elements of defense (receptors) that stimulate artificially the organism with virulent toxins, such as diphtheria. From the manner in which hypopyon is affected the corneal infiltrates cleared, and ulcer débris removed, it has occurred to me that there may be a determining factor of local resistance as the result of increased irrigation of the anterior segment of the eye, through a vasomotor or other effect, thereby supplying new and more highly activating leukocytes and other elements, if not increasing their number at one time, increasing their number over a given period of time. Clinical observation only lends some evidence in this direction, but further study of the physiologic action of the serum, certain anatomic changes, and the local effect upon intraocular tension are necessary in order to substantiate this.

From our knowledge of bacterial processes and our study of immunization one cannot, without great reserve, believe that antidiphtheritic serum may exert a non-specific influence against an ocular infection by the action of its contained antidiphtheritic specific elements against the bacteria of the invading process. That it has a bactericidal action is improbable, for almost invariably it is necessary to apply surgical means by relieving an abscess or undermined margins of a deep ulcer, or cauterization, antiseptics, etc., in order to directly destroy the organism, and without which treatment the serum may not be in itself able to combat the infection.

That the serum may possess, through its diphtheritic potency and foreign protein effect, a means of reducing the virulence of non-specific bacteria or inhibiting their growth

is a factor of importance, but obviously difficult to prove. The fact that other paraspecific therapy has shown similar results and these results so rapidly brought about, lends some evidence in this direction. And it seems reasonable to suppose that there is an effect, directly antagonistic as well as systemic, to account for such distinctive changes as are reported. Whether this is due to a phagocytic, hemolytic, or chemotactic action, or whether, by the production of non-specific antibodies, highly poisonous or antagonistic to pneumococci, a reduction in the virulence of the infection is brought about, is worthy of consideration and further study. A factor in favor of this theory may be noted in the four cases of panophthalmitis reported in which a reduced virulence seems likely.

To what extent can one depend upon antidiphtheritic serum as a paraspecific remedy? From our experiments clinically it would seem unreasonable to expect such a definite specific or bactericidal effect as would make it unnecessary to administer local treatment. Many cases argue decidedly against this theory. Not only are intensive local antiseptic measures essential, but also early and precise surgical means should be employed as the individual case demands. That these additions to the treatment of pneumococcic infections are demanded does not at all take away from the importance of the serum treatment, for no therapy, however efficacious, is always sufficient alone to cure. Paraspecific therapy is not in any sense a "cure-all," but because it is not does not detract from its curative properties. Where the knife or the galvanic or other cautery is indicated, it should be employed regardless of any reliance upon serum therapy. But, on the other hand, where the case is seen early and the serum injected, cautery or Saemisch section may be prevented, due to an early checking of the disease. Herein lies its most important therapeutic value. And, furthermore, where the process of involvement is advanced

and the cautery or knife is indicated, early relief of pain and diminished reaction follow, as does also a rapid clearing away of ulcer débris, and final opacity of the cornea is reduced. The effect upon vision obviously is a question only of early control of the infection and rapid repair and clearing of the cornea, so that should one feel justified in relying upon antidiphtheritic serum in this regard, it can be administered before extensive destructive changes take place, and thereby be a means not only of improving but saving vision in the individual case. One does not reasonably expect the serum to alone overcome a virulent hypopyon keratitis, any more than one would look for a cure of dacryocystitis, even of a low virulent organism, and treated by strong antiseptic measures with high tissue resistance, if the mechanical factor is not removed by the establishment of drainage into the nose. In the same manner proper drainage of the cornea and anterior chamber is necessary where conditions of high virulence of the organism or an advanced process are present. The action of argyrol is known not to be bactericidal or even antiseptic as regards certain microörganisms, but its usefulness in infections is undisputed and its real effect was observed and worked out after its value was established clinically. The efficacy of antidiphtheritic serum in ocular infection is like the splint to a broken bone. The splint, though curative in its effect, may be ineffective when conditions of restlessness are present, where a bit of bone or periosteum interposes as a foreign body, or specific disease, anemia, etc., may prevent healing; a cure may be finally secured only through other surgical and medical therapy.

A question of special interest and importance is that of the time of administration and the dosage. I believe when more is learned of paraspecific therapy a clearer understanding of this question will give more definitely striking results. The relationship between the time of administration and the time of other treatment is of value, especially as to per-

foration of the anterior chamber, cauterization, hot applications, subconjunctival injections, etc. It is quite evident that the effect of an injection is transient, as demonstrated by the return of hypopyon when the interval between injections was three to four days. It would be valuable to know during what time after the injection the effect of the serum is most potent, so as to time other treatment. The interval between injections and the dosage to be given also present an important relationship. My experience and that of others tends to show that 2000 units, repeated every other day, or 2000 units as an initial dose, followed daily by 1000 units for three or four doses, seems to be as efficacious as larger doses infrequently administered. And yet 1000 units alone may act remarkably upon a most resisting process, as Case No. XXII will certify, and similarly one dose of 5000 units affects a case in the same definite manner (No. I, II, III, and IV). The long period of involvement previous to the beginning of treatment must not be overlooked, for the direct effect of the serum is such that it would seem as though the tissues had already established a high local resistance, and one injection checks the infection in twenty-four to forty-eight hours. In cases where the involvement is recent the infection does not advance after forty-eight hours, as a rule, and soon there appears evidence of repair of the tissues.

It is therefore quite probable that, with more constant and numerous effects of serum treatment and with more light upon the subject of administration and dosage in relationship to the stage of the infectious process and the time of other treatment, one may prescribe antidiphtheritic serum with more confidence in the effect than at this time it is possible to have. Its prophylactic effect, if any, cannot be fairly or at all judged by previous experiments or clinical observations, for it is obvious that innumerable experiments

and long research must be made for this purpose, in order to draw comparative statistical results of any value.

CONCLUSIONS.

1. Literature on paraspecific therapy is an interesting study and research, and clinical reports of wide experience point toward a field worthy of being explored.

2. Favorable results with paraspecific therapy are by far in the majority over unfavorable reports.

3. Antidiphtheritic serum seems to have an advantage over the other paraspecific agents, because it is readily obtained, its dosage is more certain, and the preparation more dependable.

4. It has the advantage over specific serums and vaccines in that it can be utilized during the time when a bacterial diagnosis is being made and the special vaccine or serum is being prepared.

5. Indications are: In all severe infections due to pneumococcus and staphylococcus, especially hypopyon keratitis, phlyctenular pustule, penetrating wound with infection, critical ulcer of cornea, post-operative infection, and panophthalmitis.

6. It should be administered early in the course of the infection, though its effect upon the late stages is even more striking than in earlier involvement.

7. Administration by hypodermic seems theoretically more practical, though its use by mouth has been strongly advocated, with results equally as good.

8. Dosage is 5000 to 2000 units, the former infrequently repeated, the latter every day for three or four doses.

9. Adverse effects seem to have been of no importance.

10. Its principal effect is probably systemic, and to some extent reduces the virulence of the invading organism through the production of antibodies.

11. Its curative properties are demonstrated by prompt

effect upon hypopyon, reduction in conjunctival and iritic reaction, clearing away of ulcer débris, and relief of pain.

12. Its effect is limited by the presence of syphilis, untreated, and also probably by other systemic conditions.

13. It cannot be depended upon solely to combat an infection, though it may be the principal means of effecting a cure. Local measures, as indicated, are essential.

14. The time of injection in relation to the stage of involvement and the time of employment of other treatment may become a matter of special consideration and value when more is learned about paraspecific therapy.

15. The prophylactic use of antidiphtheritic serum at this time is only problematic.

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THE EYE IN HEREDITARY SYPHILIS.*

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Introduction.—It is a truism that no tissue of the body is exempt from the ravages of syphilis, and as no tissue is exempt, so every organ may be invaded by one or more of the multiform manifestations of this disease. This statement applies equally to inherited as well as to acquired lues.

So multifarious and far reaching are the aspects of syphilis, both medical and social, that many master minds have deemed the study of this disease worthy of a life-time of intense application. Some of the most brilliant deductions upon which our present fairly exact knowledge of the disease is based were made by clinicians prior to the discovery of the spirochæta pallida. Among the many investigators, two names will go down to posterity as the fathers of modern syphilology—Hutchinson and Fournier.

The knowledge that the eye might be affected in syphilis was known to some of the earliest medical writers. Johannes de Vigo, in "Aphrodisiacus" (1567), speaks of "various diseases of the eye which are caused by lues" and gives therapeutic indications. A cure of "ophthalmia gallica" by means of mercury is described by Zacutus Lusitanus (Amsterdam) in 1634.

It is a far cry from these and other early scattered allusions to the formal exposition of the subject of "Diseases of the Eye of Venereal Origin," which was given to the medical world by William Lawrence in 1830. His treatise has now only a historic interest. In those preophthalmoscopic days

* Candidate's thesis for membership accepted by the Committee on Theses.

the intraocular morbid conditions were little known, and a writer could, without fear of contradiction, give rein to any pleasant fancies he might have.

The first description of pigmented and white atrophic areas of choroiditis as a result of syphilis was given in 1856 by Wordsworth.

Bader[1] (1858) noted the presence of small circumscribed white spots in the eyegrounds in a patient who had passed through interstitial keratitis. In 1863, Hutchinson[2] described choroidal and retinal disease in hereditary lues, and in 1866[3] noted the occurrence of optic neuritis in such patients. From this date references to intraocular lesions became each year more and more frequent.

Sidler-Huguenin,[4] writing in 1902, was able to collate a large number of observations. His paper, which is by far the most exhaustive in the literature, discusses mainly the eyeground changes. He gives a careful summary of papers which have hitherto appeared, supplemented by a very detailed description and classification of the ophthalmoscopic pictures in 125 patients personally observed. Haab[5] has given this aspect of the subject special consideration, and supplements his description of the eyeground changes by several beautiful colored plates. His classification closely resembles that of Sidler-Huguenin. Hirschberg[6] has also considered at length the eyeground changes of hereditary syphilis. Groenouw[7] discusses in a very exhaustive manner, with full references to the literature up to 1904, all the ocular manifestations of hereditary syphilis. As this treatise and the paper of Sidler-Huguenin contain all noteworthy references of the participation of the eye in hereditary syphilis to this date, no attempt will be made to include in the bibliography references prior to 1904.

Allusion should be made to a thesis by Antonelli[8] in which he describes what he terms "Rudimentary Ophthalmoscopic Stigmata" of inherited syphilis. His views, which are pre-

sented with great enthusiasm and dogmatism, have received little support, and that mainly from his own countrymen. Sidler-Huguenin, Hirschberg, and Haab all speak disparagingly of Antonelli's conclusions. They regard his so-called stigmata either as appearances well within physiologic limits, or representative merely of a vice of nutrition, in which the syphilitic virus may have had an important rôle. They deny *in toto* that these stigmata are in any sense pathognomonic for syphilis.

Ocular Lesions in Hereditary Syphilis.—The incidence of ocular involvement in hereditary syphilis has been variously estimated. Among 127 cases Rabl[9] found ocular involvement in 39 per cent. Fournier found 48 per cent. of 212 syphilitic children with eye affections. According to the statistics of Ohanian,[10] about 0.5 per cent. of all ocular diseases are caused by hereditary syphilis. His conclusions were based on an examination of 29,528 diseased eyes.

Ocular lesions are rare in the newborn. As a rule, the first signs appear some weeks after birth. The explanation, according to Igersheimer,[11] is that the unborn child usually becomes infected in the last months of intrauterine life. Fetuses which were infected earlier either succumb to the infection before birth or soon afterward. In his series of 27 syphilitic nurslings 21 had ocular syphilis.

Lids.—The skin of the eyelids may participate in the general cutaneous eruption. Loss of the eyebrows may ensue. It is doubtful whether ulcerative blepharitis ever has a syphilitic basis, although Hutchinson and others have affirmed their belief in this possibility. Inflammation of the tarsus yielding readily to specific treatment has been observed in early infancy. Progressive enlargement of the tarsus is described by Basso[12] in two cases. In one the tarsus had attained the size of a pigeon's egg at the end of the seventh year. The removed mass showed hyaline degeneration of the cartilage and well-marked endarteritis obliterans.

Conjunctiva.—The specific lid eruptions are often accompanied by conjunctivitis. Igersheimer[11] is convinced of the existence of a true syphilitic conjunctivitis, which clears up under general and without local treatment. Hemorrhage from the conjunctiva, sometimes uncontrollable and leading to death, has been observed in infants the victims of hemorrhagic syphilis of the newborn. Syphilitic papules, granulomata, gummata, and ulcers may have their seat on the conjunctiva. Essential shrinkage of the conjunctiva may be an end result of syphilitic pemphigus. In a boy of fifteen with late hereditary syphilis Speciale-Cirincione[13] found a conjunctival growth which had all the histologic structure of gumma—perivasculitis with secondary proliferation of connective tissue.

Lacrimal Apparatus.—Infantile dacryocystitis is usually due to blocking of the lower end of the nasal duct with a plug of fetal detritus. However, true syphilitic periostitis of the nasal duct accompanied by specific inflammation of the sac occasionally occurs. Wood[14] examined pathologically the lacrimal glands from ten syphilitic children and found that all bore evidence of disease similar to that found in other glandular organs of syphilitics.

Cornea and Sclera.—The occurrence of parenchymatous keratitis as an incident of hereditary syphilis was known to early writers, some of whom, however, regarded "scrofula" as the most frequent cause of this disease. After Hutchinson had presented his triad of symptoms pathognomonic of hereditary syphilis,—misshapen teeth, nerve-deafness, and interstitial keratitis,—the latter acquired a greater importance as a diagnostic sign in the eyes of clinicians. Of late years a fourth symptom has been added to the triad, viz., arthritis, which has often been found associated with interstitial keratitis. Thus Puech,[15] in 27 patients with interstitial keratitis, found 11 with joint disease.

Can interstitial keratitis occur in the offspring of heredi-

tary syphilitics? In none of the reported cases can one exclude with certainty the possibility of acquired syphilis in the parents or child (extragenital postpartum infection). A well-authenticated case has recently been reported by Strezeminski.[16] On the other hand, Sidler-Huguenin found no syphilitic eye disease in 19 children of hereditary syphilitic parentage.

Interstitial keratitis has generally been regarded as the most frequent ocular complication of inherited syphilis. Statistics of various authors indicate an incidence of from 6.5 per cent. to 96 per cent. (average in 2000 cases, 50 per cent.). As is well known, the disease occurs almost exclusively in late hereditary syphilis. Very rarely the cornea is found involved at birth or the disease shows itself in the first days of life (Igersheimer).

The frequent association of keratitis with retinochoroiditis is well established. The time of the occurrence of this complication is usually after the subsidence of the keratitis. It may precede it.

Interstitial keratitis is almost always bilateral, although the eyes are not usually attacked simultaneously. The disease seems to show a slightly greater predilection for females. As is well known, a slight trauma may be the exciting cause. Vigorous specific treatment instituted to cure a unilateral syphilitic keratitis will not usually prevent the development of the disease in the fellow eye or relapses in the eye first attacked. On the other hand, intensive and prolonged treatment of a syphilitic infant prior to the appearance of keratitis will usually prevent its development in either eye.

Very rarely other types of corneal disease have been observed. Groenouw cites Kerabutsi and Outsi[17] who observed punctate keratitis, and Sendziak[18] who reports sclerosing keratitis. Neuroparalytic keratitis dependent on disease of the trigeminus was noted by Fromaget.[19] Keratomalacia has been observed in very greatly emaciated children.

Peltesohn[20] reports two cases cured by specific treatment. Fuchs[21] has recently noted the occurrence of vertically oval cornea in hereditary syphilis. Of 28 cases observed, 14 had interstitial keratitis. He concludes that vertically oval cornea is relatively more frequent in hereditary syphilis and seems to be the precursor of interstitial keratitis. Distention of the scleral and corneal tissues through increased intraocular tension may lead to megalophthalmos, as in a case reported by Arning.[22]

Muscles.—Paralysis of the intrinsic and extrinsic muscles and paralysis of the trigeminus have been observed. The oculomotor and abducens may be partially or completely paralyzed. A unilateral internal ophthalmoplegia is almost certainly due to syphilis. Igersheimer has reported 8 cases of nystagmus without ophthalmoscopic signs in syphilitic babies; improvement or cure took place under specific therapy. Zappert[23] has observed a complete ophthalmoplegia as the sole manifestation of tardy hereditary syphilis.

Whether or not concomitant strabismus bears any relation to hereditary lues is an undecided question. Antonelli observed squint in 50 per cent. of children with hereditary syphilis. Statistics from other authors indicate a lower incidence.

Iris and Ciliary Body.—Iritis, which was first described as an ocular complication by Lawrence, is infrequent as compared with the occurrence of the disease in acquired syphilis. Sidney Stephenson[24] says: "The disease must be exceedingly rare, for I cannot recall in my own work having recognized a single case." It may be present at birth. Owing to the lack of systematic examination of syphilitic infants' eyes, it is probable that we do not, at the present time, know even approximately the true incidence of this disease. Usually of a "quiet" type, it gives rise to few of the classic symptoms and may run its course without the parent suspecting ocular disease. In the absence of marked ciliary congestion and

pain, discoloration of the iris and sluggishness or immobility of the pupil are the important diagnostic signs. Not rarely a mydriatic will reveal synechiæ in cases with very slight clinical signs. Serous iritis with deposits on Descemet's membrane has been described. The disease may also simulate the nodular or gummatous iritis of adults. Recently Igersheimer[11] has described what he calls "syphilitic pseudoglioma." A severe plastic inflammation of the iris and ciliary body results in the filling of the pupil with a yellowish mass which soon becomes covered with vessels. This is apt to result in closure of the pupil with secondary glaucoma. A gumma of the ciliary body, appearing as a round red boss 10 mm. behind the corneal margin, has been described by Panas.[25]

Lens.—Clouding of the lens is for the most part secondary to disease of the uvea or retina. Posterior polar cataract in a syphilitic brother and sister with diffuse retinitis is reported by Riegel.[26] Zonular cataract is stated by Bull[27] to be usually of syphilitic origin.

Vitreous.—Many cases of retinochoroiditis are associated, at least in the beginning, with vitreous haze, which may seriously interfere with vision. Sidney Stephenson[24] describes a form of amblyopia in children due to opacities in the vitreous. The individual particles are usually so small that they cannot be distinguished. Fluctuation in sight is an important diagnostic point. He believes that in children "a cloudy vitreous humor means one thing only, *e. g.*, the existence of congenital syphilis."

Eyegrounds.—Disease of the eyeground in hereditary syphilis was first described by Bader[1] and Drognat-Landré.[28] The literature contains a large number of isolated observations, but there was little attempt at classification until the exhaustive treatise of Sidler-Huguenin[4] appeared. This monograph of 256 pages (1902) contains a very complete summary of the literature, together with a detailed account

of the general physical and ophthalmoscopic findings in 125 hereditary syphilitics. On the basis of this study this author has divided the retinochoroidal changes in hereditary syphilis into four types, as follows:

Type I: Innumerable fine, roundish, yellowish-red dots, intermingled with equally fine brown or black pigment dots, comparable to black pepper sprinkled over a yellowish red background. This mild form is often present only in one quadrant of the fundus. The peripapillary zone and macula are not often involved. The disc may be normal or pale, but is not atrophic. Vision is usually normal. In more pronounced cases the pigment spots may be large and angular and approach or invade the macula. The nerve is pale—partial atrophy. The retinal vessels are narrowed. Vision is poor. The changes all lie in the retina.

Type II: Larger pigment masses, isolated or confluent, are situated at the periphery. Between these masses are round, reddish-yellow foci which are not so numerous as the pigmented ones. They show little tendency to merge. The disease is situated primarily in the choroid. The nerve may undergo partial or complete atrophy. Sometimes the eye-ground between the areas is a leaden hue, traversed by bands of connective tissue. Type II is often found after the subsidence of interstitial keratitis.

Type III: Consists of round or oval, light-colored areas, usually situated at the periphery. They may extend back toward the posterior pole. Some of the areas remain small; others coalesce and become very large. Prolongations may extend toward the posterior pole. Bordered by pigment, the areas themselves may become lightly pigmented. The disease is probably situated for the most part in the choroid. To this type belongs choroiditis alveolaris. Vision is impaired only when the macula is involved.

Type IV: Bears a striking resemblance to retinitis pigmentosa; cannot, indeed, always be differentiated from it.

The nerve-head is atrophic, with narrowed vessels. The pigment masses are more rounded and larger than in retinitis pigmentosa, and alternate with yellowish-red and gray-white atrophic spots. The peripapillary zone is leaden hued. Vision and light sense are diminished.

Three colored plates, illustrating respectively Types I, II, and III, are given by Haab.[5] As his descriptions of these different appearances are very clear, it has seemed worth while to reproduce them. Of Fig. 39, representing Type I, Haab has this to say: "The periphery in the lower left-hand portion of the picture presents a leaden hue, and coal-black circular and triangular pigment patches. The rest of the eyeground is covered with minute yellowish-red spots. The yellowish-red rounded spots stand out from the brown dotted background, which looks as if it were sprinkled with snuff. The retinal vessels are rather small and the optic nerve somewhat discolored. Sometimes the sprinkling is found only in the periphery of the eyeground. But whenever this sprinkling is at all well marked, it indicates hereditary lues."

Fig. 40, representing Type II, is thus described: "The disease is often confined for a long time to the periphery. . . . The pigment patches are probably, for the most part, situated in the retina, and are caused by a disease of the pigment epithelium. I am unable to decide whether the pale linear and circular yellowish patches are situated in the choroid or in the pigment epithelium. They may be situated in one or the other. This and the following form of the disease are not rarely found after a diffuse interstitial keratitis if, after the cornea has become sufficiently cleared up, the periphery of the eyeground is carefully examined. In some cases the patches may be confined to one side; in others they may be scattered more or less over the entire eyeground and on both sides. In the case here presented there had been a keratitis."

Of Fig. 41 he says:

"In place of the black and gray patches which predominate both in size and number in the foregoing picture, we find in some cases only whitish, also circular, and often confluent patches. The larger of these are undoubtedly situated in the choroid. This is shown in the figure by the oval white patch traversed by a red vessel. It is a choroidal vessel, hence the choroidal tissue near the vessel is absent and the white of the sclera shows through. There is no doubt, however, that the pigment epithelium of the retina has disappeared at the site of the patches and is slightly increased about their margins, so that the margins appear somewhat darker than the surrounding tissue. This condition also followed an attack of parenchymatous keratitis. Occasionally the forms shown in Figs. 40 and 41 are associated, resulting in a mixture of both dark and light circular confluent patches at the periphery, while sometimes in addition we find the form shown in Fig. 39, viz., minute red and yellow spots on a brown mottled background, with a sprinkling of small pigment patches. In general these three types of hereditary specific eyeground disease show a tendency to the formation of spheric foci, which coalesce and form irregular figures."

Most of the intraocular lesions of hereditary syphilis may, according to Hirschberg,[6] be placed in one of the following four groups: First: Anterior hyalitis, consisting of fine, dust-like opacities. Second: The nerve-head is covered with a delicate veil gradually fading into the surrounding retina. Under treatment the veil may disappear, although the nerve-head never regains its "virginal" tint. Some cases recover, but with connective-tissue formation on the disc. Third: The macular region presents a uniformly brown discoloration. Fourth: The fundus is strewn with countless small, light-colored areas, more numerous near the periphery. There is frequently a pigment dot in the center and pigment massing along the border.

It is often a difficult matter, even for the most experi-

enced ophthalmoscopist, to determine with certainty whether a given appearance signifies a pathologic state or is merely a deviation from the physiologic. For instance, the tint and outline of the nerve-head, the course and caliber of the vessels, the color and texture of the macula, the amount and character of pigmentation in the periphery all vary, and sometimes widely, within physiologic limits. What to one observer may have significance, either as a deviation from the normal sufficiently wide to be considered pathologic, or as a special stigma of a constitutional vice, may, to another, be wholly within physiologic bounds.

Whether there exist veritable ophthalmoscopic stigmata of hereditary syphilis or not, there was not wanting an Italian, A. Antonelli,[8] to assert with conviction that such stigmata existed, and to defend his position in a thesis presented before the Faculty of Medicine of Paris. Antonelli believes that certain ophthalmoscopic appearances which ordinarily have been classified as physiologic deviations, have true significance as stigmata of hereditary syphilis. He says: "Les lesions du fond de l'oeil comptent parmi les manifestations les plus frequent de la syphilis congenitale, et que ces signes ophtalmoscopiques sont souvent les seule qu' il soit possible de reconnaitre d'emblee, si l'on est prevenu de la chose et si l'on est assez rompu aux finesses de l'ophtalmoscopie."

Rudimentary ophthalmoscopic stigmata are, according to Antonelli's definition, "lesions which cause no functional disturbance, are not likely to be discovered in the ordinary routine of examination, and are so insignificant that they may readily pass unperceived by the ophthalmoscopist."

These stigmata concern: 1. The color, margins, and vessels of the disc. 2. The appearance of vessels as they pass over the disc margin and in the peripapillary zone. 3. Color and pigmentation of the peripapillary and central areas.

4. Alterations in the center, equator, and periphery of the eyeground.

The following is a synopsis of these stigmata: The papilla is pale or gray over all, or in sectors; the margin is veiled. A pigment mass ("cadre pigmentaire") bordering the disc is sharply defined on the side of the disc and shades off to the retina. The arteries are narrowed, the veins are full. There are irregularities of caliber. The vessels on and near the disc are partially obscured. In the peripapillary region there exists: (1) Retinal edema, often limited to the space between two vessels; (2) a typical slate color, shading off toward the equatorial region. There may be punctate pigmentation, which, when situated peripherally, bears resemblance to pigmentary degeneration of the retina.

It is not surprising that Antonelli's dicta have failed to find wide-spread support. Most ophthalmoscopists can hardly bring themselves to regard a choroidal pigment ring or regional obscurations of vessels as significant of syphilis or any other disease. On the other hand, the gray nerve-head and the brown punctate pigmentation are appearances that all other observers have noted, and they doubtless have a real significance. A careful critique of Antonelli's work was made by Herbout,[29] who divides these stigmata into two categories: 1. Those which are only modifications of the pigment epithelium—choroidal ring, and slate color of the peripapillary region. They have no more significance than irregularities of pigment distribution in the skin, hair, or iris. They are simply marks of degeneration. 2. Those which are indications of past optic neuritis; pallid disc with obscured borders, narrowed arteries, and voluminous veins.

Disease of the retinal vessels (arteries, veins, capillaries) is indicated by the development of perivascular white lines and eventually by the transformation of the vessels into solid white strands. Retinal hemorrhages or choroidal atrophic areas may be associated with the diseased vessels. Under

specific treatment the vessels may be restored to normal. Oliver[30] has described a rare type of perivasculitis in which the arteries and veins were exceedingly dilated. Igersheimer notes the frequency of a pale silver gray tint of the optic disc, which probably is the intraocular expression of a high-grade anemia. One such nerve examined histologically showed neither inflammation nor degenerative changes.

Primary optic neuritis occurs in hereditary as well as in acquired syphilis, and may result in secondary optic atrophy. Heine[31] insists that optic neuritis is very common in syphilitic infants. His material, from Neumann's clinic, indicated that of 105 syphilitic babies, 86 (81.9 per cent.) had optic neuritis. He asserts that optic neuritis may be the sole sign, in addition to a positive Wassermann, of hereditary syphilis, and hence that it has great diagnostic significance. This very large percentage has not been found by other observers. It is questionable whether a primary atrophy occurs. There seems good grounds for believing that tabetic optic atrophy may occur (Lervit[32]).

It is important to note that eyeground changes may escape observation for the reason that usually they give rise to no symptoms. Very rarely is the infant so blind that he cannot grasp at toys and in other ways comport himself as a normal child, so that only by a systematic examination of the eyeground of every syphilitic child will these changes invariably be brought to light.

Orbit.—Periostitis of the orbit, involving, as a rule, the upper part of the orbit, has been noted in hereditary, as well as in acquired, syphilis. Pain and exophthalmos are prominent symptoms. Optic neuritis or choking due to interference with the venous return may occur. Sometimes the process goes on to pus formation. Tumors and tuberculosis of the orbit must be excluded.

Miscellaneous.—Primary glaucoma has never been observed. Increased tension may occur as an incident in the

course of retinochoroiditis or iritis. Congenital anomalies, such as microphthalmos, coloboma of the iris, corectopia, congenital cataract, ectopia lentis, defects of the lens, and choroidal coloboma have been ascribed by some authors to hereditary syphilis.

Pathology.—A consideration of the pathology of the ocular lesions of hereditary syphilis is outside the scope of this paper. A very complete summary, up to 1902, of the rather scanty literature bearing on the pathology of retinal, choroidal, and optic nerve lesions is given by Sidler-Huguenin (p. 30). (For a systematic discussion the reader is referred to Parsons, Pathology of the Eye, 1904, vol. i, pp. 5, 78, 191, 278, 294, 354; vol. ii, pp. 406, 434, 461, 615, 683.)

The present study was undertaken to gain some conception of the extent to which the ocular tissues participated in the lesions of inherited syphilis. The work was entered into with an open mind and without knowledge of the results of similar studies which had previously been published.

The material came exclusively from the Pediatric Clinic of Washington University Dispensary and the wards of the St. Louis Children's Hospital. A number of these patients applied primarily to the eye clinic and were referred to the pediatric clinic for diagnosis and treatment. It is believed that the 100 cases fairly represent the types of hereditary syphilis seen in a pediatric service, and that the number and kinds of ocular complications are what might be expected in such a group.

No child was included in whom the clinical diagnosis of hereditary syphilis was not confirmed by at least a ++ blood Wassermann. In 48 children a spinal fluid Wassermann was made in addition. To the best of my knowledge the present is the only ocular study in which the clinical diagnosis has been confirmed in every case by a serologic test. The examination of each child's eyes was conducted systematically

and recorded on a prepared blank, which included the following points to be investigated: 1. Name. 2. Age. 3. Sex. 4. Color. 5. Clinical diagnosis. 6. Localization of syphilitic lesions. 7. General complications (non-syphilitic). 8. Blood Wassermann. 9. Spinal fluid Wassermann. 10. Pupils (size, equality, reactions). 11. Ocular muscles (strabismus; paralytic or concomitant; internal or external). 12. Conjunctiva. 13. Cornea (clear, nebula, leukoma, keratitis, salmon patch, ulcer, vascular remains). 14. Descemet's membrane (deposits). 15. Anterior chamber (clear, cloudy). 16. Iris (color, iritis, synechiæ). 17. Lens. 18. Vitreous. 19. Eyegrounds (disc, arteries, veins, perivasculitis, edema, exudate, hemorrhage, pigmentation, depigmentation). 20. Ophthalmoscopic diagnosis (full description).

The original diagram tabulating results contained columns for recording under these 20 headings. It was found possible and desirable, in the interest of brevity, to omit from the final tables the headings "localization of syphilitic lesions," "general complications," "conjunctiva," Descemet's membrane," "lens," "vitreous," and "ophthalmoscopic diagnosis," and to include in a general heading, "remarks," the occasional abnormality which would have been recorded under the omitted headings. In fully one-third of the cases any visual test was impossible on account of the age of the patient, and hence vision was not taken as a routine.

An examination of this tabulation will show that 74 of these children presented definite pathologic conditions in one or more of the ocular tissues or some derangement of ocular function. Some of these conditions, such as interstitial keratitis, immobile pupils, optic atrophy, and certain eyeground changes can with assurance be ascribed to the syphilitic virus. Others, such as concomitant squint and pallor of the nerve-head, may depend upon some factor other than syphilis. Cases of this character were not included in the group of 74 unless they presented, in addition, definite syphilitic ocular lesions.

No.	Age	Sex and Color	Pupils	Muscles	Cornea	Iris	Eyegrounds	B. W.	S. F. W.	Clinical Diagnosis	Remarks
1	13	F. W.	R. [illegible] L., react.			Hazel.	R., disc hyperemic, margins veiled. Small round clumps of hyperpigmentation alternating with areas of depigmentation. L., the same.	[illegible]	[illegible]	Hereditary syphilis.	V.R.E., 6/5; V.L.E., 6/5. Nerve deafness.
2	11	M. W.	Equal, react.		Both nebulous from former keratitis.	R., gray. L., piebald.	R. and L., lower periphery punctate with fine brown dots.	[illegible]	[illegible]	Latent hereditary syphilis.	Eyes very sore at age five.
3	9	F. W.	Equal, react.		. .	Hazel.	R. and L. normal.	++	[illegible]	Hereditary syphilis.	. . .
4	10 mos.	M. W.	R. and L. miosis, react.			Hazel.	Both discs pale, margins veiled. Retinæ very pale, vessels narrowed.	++++	[illegible]	Hereditary syphilis.	Square rachitic head. Spleen enlarged.
5	10	M. W.	Equal, react.		R., nebula below. L., dots of central infiltration.	Blue.	R., disc veiled above. L., upper and nasal margins obliterated, retinochoroidal spots.	[illegible]	[illegible]	Hereditary syphilis.	V.R.E., 6/8; V.L.E., 6/5.
6	8	F. W.	L. [illegible] R. L. fixed.			Hazel.	R. and L., partial optic atrophy, perivasculitis. "Peppered" generally; macula presents larger pigment clumps overlying retinal vessels.	[illegible]	0	Syphilitic spastic paraplegia.	Partial optic atrophy with disseminated chorioretinitis. Marked tendency for pigment to wander together in clumps.
7	1	F. Col.	Equal, sluggish.			Brown.	Both discs pale. Irregular peppering tending to clumping.	[illegible]	0	Hereditary syphilis.	Mother states baby's eyes weak in bright light. Small and undernourished.
8	9	M. Col.	Equal, react.			Brown.	R. and L. normal.	[illegible]	[illegible]	Hereditary syphilis.	Subjectively well.
9	11½ mos.	F. W.	Equal, react.			L., irritis, synechia up.	R., disc pale. Veiled. Arteries narrow. Veins full. L., red reflex only.	[illegible]	[illegible]	Hereditary syphilis.	R., post neuritic atrophy. L., iritis, hyalitis. Died of bronchopneumonia.

No.	Age	Sex and Color	Pupils	Muscles	Cornea	Iris	Eyegrounds	B. W.	S. F. W.	Clinical Diagnosis	Remarks
10	1 mo.	M. W.	Equal, react.			Hazel.	R., disc pale. Veiled; veins full, not tortuous. L., "peppered" fundus, marked at macula. Veins full, not tortuous.	++++	0	Hereditary syphilis.	
11	5	F. W	Equal, react.	R., external squint Not paralytic.		Hazel.	R., optic atrophy. L., normal.	+++	0	Hereditary syphilis.	Rapid lateral nystagmus At times eyes are quiet Idiocy. Carious teeth, pyorrhea.
12	5	F. W.	Equal, react.	..		Brown.	R. and L. normal.	++++	—	Hereditary syphilis.	Pertussis. Chronic bronchitis.
13	11 mos.	F. W.	Equal, react.	..	..	Gray.	R. and L. normal.	++++	—	Hereditary syphilis.	
14	7	F. W.	Equal, react.	..	R. and L., interstitial keratitis.	Brown.	R. and L. normal.	++++	0	Hereditary syphilis.	Old poliomyelitis. Residual paralysis.
15	5	M. W.	Equal, react.	..	R., small infiltration.	Hazel.	R., disc decidedly pale. L., normal.	++++	0	Hereditary syphilis.	Premature infant. Poor nutrition.
16	3	M. W.	Equal, react.	..	..	Brown.	R. and L. normal.	++++	—	Hereditary syphilis.	Evidence of former rachitis.
17	1	M. W.	Equal, react.	..	..	Brown.	Both discs very much congested. Margins veiled.	++++	0	Hereditary syphilis.	Rachitis.
18	2	M. W.	Equal, react.	..	..	Hazel.	Both fundi "peppered."	+++	0	Hereditary syphilis.	. . .
19	1	F. W.	Equal, react.			Brown.	Choroidal rings. Uneven distribution of pigment at macula.	++	—	Hereditary syphilis.	Pulmonary tuberculosis.
20	3	F. W.	L. > R. L. fixed.	..	..	Gray.	R., nerve head pale, margins veiled. Numerous round masses consisting of a pigment ring surrounding a depigmented annulus. Center of each frequently occupied by a gray pigment spot. Interpigmented	++++	++++	Cerebral syphilis.	Hemiplegia.

							spaces are "peppered." L. the same.				
21	9	F. W.	Equal, react.	.	. .	Gray.	R., temporal margin of disc and adjacent retina edematous. Disc pale. L., the same. In addition, diffuse pigmentation of retina.	++++	0	Cerebrospinal syphilis.	Hemiplegia, right cortex.
22	10	M. W.	Equal, react.		.	Hazel.	R., optic neuritis. Tortuous veins. L., optic neuritis with peppering lower part of fundus	++	0	Hereditary syphilis.	Postpharyngeal membrane.
23	14	F. W.	L. : R L. fixed		R., temporal nebula. L., small nebula.	R. Iritis. Brown	R., disc atrophic. Vessels extremely attenuated. Rounded pigment masses in macula. L., chorioretinitis. Rounded pigment masses in upper retina. Vessels attenuated.	++++		Hereditary syphilis	Paralytic mydriasis. No other clinical signs.
24	8	M. W.	Equal, sluggish.	R., partial ptosis.	.	Gray.	R., disc pale. Margins veiled. L., disc slightly pale. Margins better defined.	++++	++++	Cerebrospinal syphilis.	Mental deficiency.
25	12	F. W.	Equal, react	. .	R., keratitis. L., old vascular remains	Hazel.	R. and L. normal.	++++		Hereditary syphilis.	Gumma wall of pharynx.
26	6	F. Col.	Equal, react.	Internal strabismus	. .	Brown	L., retinochoroidal atrophy upper part of fundus. R., normal.	++++	+++	Cerebrospinal syphilis	
27	6	M. W.	R., very sluggish L., 3.5 mm. react.	.	.	Gray	Optic neuritis; both maculæ very granular.	++++	++++	Hereditary syphilis	
28	10	M. W.	Equal, react.		.	Brown.	R., congested disc. Edema of retina to nasal side. L., optic neuritis. Several minute retinal hemorrhages.	++	0	Hereditary syphilis	Bronchitis.

No.	Age	Sex and Color	Pupils	Muscles	Cornea	Iris	Eyegrounds	B. W.	S. F. W	Clinical Diagnosis	Remarks
29	6	M. W.	L. > R., sluggish.	..	..	Brown.	R., neuroretinitis punctata. Periphery finely "peppered." L., the same.	+++	+++	Cerebro-spinal syphilis.	Paresis (?)
30	6	F. W.	Equal, react.			Hazel.	R. and L., "peppered" fundus. R. shows irregular pigment distribution at temporal margin.	+++	0	Hereditary syphilis.	Pulmonary tuberculosis.
31	10	M. W.	Equal, react.	.	..	Brown.	R. and L. normal.	++++	+++	Cerebro-spinal syphilis.	Idiocy.
32	13	M. W.	Equal, react.	..	..	Blue.	R., temporal pallor, obscuration of nasal half of disc. Splotches of retinal pigment around disc, granular macula. L., the same.	++++	0	Hereditary syphilis.	Orthostatic albuminuria.
33	13	F. W.	Equal, react.	..	..	Blue.	R. and L., congested discs. Brown punctation in maculæ.	++++	0	Hereditary syphilis.	Slightly feebleminded.
34	2	M. W.	Equal, react.	..	..	Blue.	R. and L. macular regions look as though dusted with pulverized pepper.	++++	0	Hereditary syphilis.	....
35	13	F. W.	Equal, react.	.	R., central scar from exposure.	R., iritis.	R. and L. normal.	+++	0	Hereditary syphilis.	Large syphilitic ulcer of frontal region. Lower eyelid destroyed by ulceration.
36	14	M. W.	Equal, react.	..	..	Hazel.	R. and L., marked retinal haze. R., depigmented area bordered by pigment.	++++	0	Hereditary syphilis.	Gumma of liver.
37	8	F. W.	Equal, react.	..	Both, old interstitial keratitis.	Brown.	R. and L. normal.	+++	—	Hereditary syphilis.	.
38	6	M. W.	Equal, react.	.	R. and L., nebulæ.	Hazel L., iritis.	R., upper and lower periphery show a	++++	0	Hereditary syphilis.	..

								few patches of depigmentation.				
39	13	F. W.	R. > L. R., sluggish.	.	.	Brown.	R. and L., normal.	++++	—	Hereditary syphilis.	L., posterior polar opacity. Mental deficiency.
40	11	M. W.	Equal, react.	.		Hazel.	R. and L., partial optic atrophy.	++++	0	Hereditary syphilis.	Chronic bronchitis.
41	4 mos.	M. W.	Equal, react.			Hazel.	R. and L., normal.	++++	+++	Hereditary syphilis.	Dermatitis; diarrhea.
42	8 mos.	F. Col.	Equal, fixed.		.	Gray. L., ectropion uveæ.	R. and L., normal.	+++	—	Hereditary syphilis.	Very rapid lateral nystagmus — about 150 oscillations a minute.
43	9	F. W.	Equal, react.		. .	Hazel.	R. and L., dises very red. Fine pigmentary deposits throughout.	++	—	Hereditary syphilis.	R., ptosis; arthritis of knee. V.R.E., 6/12; V.L.E., 6/5.
44	9	M. W.	Equal, react.		R. and L., nebulæ from old interstitial keratitis.	Brown.	R. and L., probably normal. Corneal haze.	++	—	Hereditary syphilis.	Marked rhagades at oral angles.
45	9	M. W.	Equal, react.		. .	Brown.	R. and L., optic neuritis.	+++	0	Hereditary syphilis.	Osteomyelitis of tibia.
46	6	M. W.	Equal, react.		R., central nebula from old keratitis. L., normal.	Gray.	R. and L., areas of fine brown punctation alternating with depigmented spots.	++	0	Hereditary syphilis.	.
47	12	F. W.	R. and L., marked hippus.		. .	Gray.	R. and L., very well-marked choroidal ring; upper part of fundus distinctly peppered. Temporal pallor.	+++	0	Hereditary syphilis.	. .
48	9	M. W.	Equal, react.			Hazel.	L., disc very hyperemic, with blurred lower border. R., normal.	++	0	Hereditary syphilis.	Large square head. Facial asymmetry.
49	1	F. W.	Equal, sluggish.			Hazel.	R. and L., marked peripapillary pigment punctations.	++++	+++	Hereditary syphilis.	Malnutrition. Sores on body. Died.
50	2 mos.	M. W.	Equal, react			Gray.	R. and L., dises slightly pale.	++++	0	Hereditary syphilis.	Rash on neck, ankles, and wrists. Epiphysitis. Paralysis of both arms.

No.	Age	Sex and Color	Pupils	Muscles	Cornea	Iris	Eyegrounds	B. W.	S. F. W.	Clinical Diagnosis	Remarks
51	9	F. W.	Equal, react.	..	R. and L., remains of former keratitis.	Blue.	R., temporally 6 to 8 round and oval areas of retinochoroiditis. L., 15 to 20 areas of retinochoroiditis in temporal periphery.	+ + + +	0	Hereditary syphilis.	Saddle-nose.
52	3	M. W.	Equal, react.	Alternating squint.	.	Brown.	R. and L., discs pale; entire fundi as though sprinkled with fine black pepper.	+ + +	—	Hereditary syphilis.	Idiocy.
53	3	F. W.	Equal, react.	.	R. and L., beginning keratitis.	Hazel.	R. and L., optic neuritis. Central and peripheral punctate depigmented dots.	+ + + +	0	Hereditary syphilis.	Arthritis of knee.
54	4	F. W.	Equal, sluggish	.	..	Brown.	L., small area of retinochoroidal atrophy down and in. R., normal.	+ + + +	+ + + +	Cerebrospinal syphilis.	Mental deficiency.
55	1	M. W.	Equal, react.	.	..	Hazel.	R. and L., partial optic atrophy.	+ + + +	0	Hereditary syphilis.	Papulosquamous eruption.
56	8	F. W.	Equal, react.	..	R. and L., nebulæ from antecedent keratitis.	Brown.	Both discs very pale. Peripapillary edema below. Both peripheries diffusely peppered.	+ + + +	0	Hereditary syphilis.	Nerve-deafness.
57	3	M. W.	Equal, react.	..	..	Hazel.	R. and L., normal.	+ +	—	Hereditary syphilis.	.
58	5	M. W.	Equal, react.	.	.	Brown.	R. and L., marked peripheral peppering.	+ + + +	+ + + +	Hereditary syphilis.	Rash on trunk.
59	1 mo.	M. W.	Equal, react.	..	..	Hazel.	R. and L., normal.	+ + +	0	Hereditary syphilis.	. . .
60	9	F. W.	Equal, react.	..	..	Gray.	Both nerve heads much blurred and pale.	+ + + +	—	Hereditary syphilis.	Chorea.
61	9	M. W.	Equal, react.	..	..	Gray.	Both eyegrounds show, in upper periphery, numerous brown punctations.	+ + + +	0	Hereditary syphilis.	Maculopapular eruption.
62	2 mos.	F. W.	Equal, react.	..	..	Hazel.	Discs pale, retinæ very thin, tesselated eyegrounds.	+ + +	0	Hereditary syphilis.	Bloody crusts on skin. Died.

63	2	M. Col.	Equal, sluggish.	..	..	Brown.	R. and L., nerves completely atrophic. Disc surfaces devoid of blood-vessels. Sclerosis of peripapillary choroidal vessels.	+++	0	Cerebro-spinal syphilis.	Blind.
64	7	F. W.	Equal, react.	..	R. and L., keratitis.	Hazel.	L., upper temporal vein greatly dilated. R., normal.	+ +	—	Hereditary syphilis.	Condition of left supramacular vessels suggests that at one time there had been retinal hemorrhage.
65	2 mos.	F. W.	Equal, sluggish.		..	Gray.	Both discs pale; papillary and peripapillary edema, veins overfull.	+ +	0	Hereditary syphilis.	Spleen enlarged.
66	5 mos.	M. W.	R. > L., react.	Slight divergent strabismus.		Gray.	R. and L., marked veiling of papillæ and circumpapillary retina.	- -	--	Hereditary syphilis.	Both lower lids are slightly inverted.
67	3	M. Col.	Equal, react.	..	..	Brown.	Both eyegrounds show marked diffuse pigment punctation.	+ +	+ +	Hereditary syphilis.	. . .
68	7 mos	F. W.	Equal, react.	.	..	Gray.	R. and L., marked diffuse pigmentation.	+ + +	0	Hereditary syphilis.	Skin eruption.
69	3	M. Col.	Equal, react.	.	..	Brown.	R. and L., normal.	+ +	—	Hereditary syphilis.	. . .
70	4	F. Col.	Equal, react.	..	..	Brown.	R. and L., normal.	++++	+ +	Hereditary syphilis.	. .
71	4	M. W.	Equal, react.	Alternating strabismus.	.	Hazel.	R., haze of macula and pale disc. Small retino-choroidal spot. "Peppered fundus." L., disc pale and veiled. Several retinochoroidal atrophic spots. Perivasculitis. Thin membrane overlying retinal vessels below.	++++	+ + + +	Hereditary syphilis.	Remains of hyaloid artery. Arthritis right knee.
72	2	F. Col.	Equal, react.	.	..	Brown.	R. and L., normal.	+ + + +	0	Hereditary syphilis.	Syphilids on face.
73	6 mos	M. W.	Equal, react.		..	Brown.	R. and L., normal.	+++	0	Hereditary syphilis.	Has no clinical signs. Wassermann made because mother had syphilis.

No.	Age	Sex and Color	Pupils	Muscles	Cornea	Iris	Eyegrounds	B. W.	S. F. W.	Clinical Diagnosis	Remarks
74	1	F. Col.	Equal, react.		.	Brown.	R. and L., normal.	++	0	Hereditary syphilis.	Mother has + + Wassermann. Had skin rash.
75	5	F. W.	Equal, react.		R. and L., scars from old keratitis.	Blue.	R. and L., marked choroidal pigment rings.	++	0	Hereditary syphilis.	Conjunctiva congested.
76	7 mos.	F. W.	Equal, react.		..	Gray.	R. and L., normal.	+ + +		Hereditary syphilis.	Snuffles, pad palpable spleen rhagades.
77	11	M. W.	Equal, react.	..	.	Brown	Both discs very pale.	+	0	Hereditary syphilis.	
78	11	M. W.	Equal, react.		..	Hazel.	R. and L., fundus mottled. L., perivasculitis.	+	0	Hereditary syphilis.	R. and L., anterior hyalitis.
79	9	F. W.	Equal, react.			Hazel.	Discs pale and filled in. Round dense black pigment areas, apparently in retina, in places overlying retinal vessels; macular regions punctate, with dark pinpoint pigmentation.	+	0	Hereditary syphilis.	Extreme nervousness
80	7 mos.	F. W.	Equal, react.	..		Blue.	R. and L., normal.	++	0	Hereditary syphilis.	. .
81	5 mos.	M. Col.	Equal, react.	..	..	Hazel.	Examination unsatisfactory; apparently normal.	++	0	Hereditary syphilis.	Eruption on trunk and face.
82	11	F. W.	Equal, react.	..	..	Hazel.	Both discs pale. Edematous. Also peripapillary edema.	++	+	Hereditary syphilis.	. . . .
83	5	F. W.	Equal, react.	..	..	Hazel.	R. and L., normal.	++	0	Hereditary syphilis; latent.	.
84	3 mos	M. W.	Equal, react	..	..	Hazel.	R. and L., normal.	++	0	Hereditary syphilis.	Anal condylomata; conjunctivitis.
85	6	M. W.	R. = L. react.		.	Gray.	Finely granular, probably physiologic.	+	0	Hereditary syphilis.	. . . .
86	8	M. W.	Dilated, equal, sluggish.			Hazel.	Both fundus peripheries evenly punctate with dark-brown dots.	+	0	Hereditary syphilis.	
87	1	M. W.	Equal, react.	..	..	Gray.	Both, numerous pigment dots of varying size, alternat-	++	0	Hereditary syphilis.	.

							ing with tiny areas of light color.				
88	8	M. W.	Equal, react.	..	R. and L., old scars of keratitis.	Brown.	Both, peripheral brown and black punctations.	+ +	—	Hereditary syphilis.	. . .
89	3	F. W.	Equal, react.	Nystagmus.	..	Gray.	R., optic atrophy. Several round white circular areas with pigmented center. L., optic atrophy.	+ + + +	+ + + +	Cerebro-spinal syphilis.	Child evidently nearly blind.
90	2	F. W.	Dilated, very sluggish.	Searching movements.	.	Hazel.	R. and L., optic atrophy.	+ + +	+ +	Cerebro-spinal syphilis.	Sees very poorly.
91	7	M. W.	Equal, react.	..	R. and L., remains of antecedent keratitis.	Hazel.	R. and L., pigment masses of varying sizes and shapes alternating with light areas in upper periphery.	+ + + +	—	Hereditary syphilis.	.
92	9	F. W.	Equal, react.	..	R., central nebulæ. L., dense central vascular scar.	Hazel. L., synechia.	R. and L., no view of eyegrounds on account of corneal scars.	+ + + +	—	Hereditary syphilis.	.
93	10	F. W.	Equal, react.	R., convergent squint.	R. and L., nebulæ from old keratitis.	Brown.	R. and L., numerous yellow white, round, approximately equal, punctations in periphery.	+ +	—	Hereditary syphilis.	Nerve-deafness.
94	9	F. W.	Equal, react.	..	..	Brown.	R. and L., normal. Myopia.	+ + + +	—	Hereditary syphilis. Latent.	Speech defect.
95	8	F. W.	R. > L. react.	.	..	Gray.	R. and L., normal.	+ + + +	0	Hereditary syphilis.	Poorly nourished.
96	13	F. Col.	Equal, react.	.	R., scars of antecedent keratitis.	Brown.	R. and L., normal.	+ + +	—	Hereditary syphilis.	. . . .
97	9	M. W.	Equal, react.	.	..	Brown.	R. and L., normal.	+ + + +	0	Hereditary syphilis.	
98	8	M. Col.	Equal, react.	..	..	Brown.	R. and L., normal.	+ + +	—	Hereditary syphilis.	Oral ulceration. Gum adherent to cheek.
99	8	F. W.	Equal, react.	.	..	Brown.	R. and L., normal.	+ +	—	Hereditary syphilis.	Papular and vesicular eruption.
100	6	M. W.	Equal, react.	..	..	Hazel.	R. and L., optic neuritis.	+ + +	0	Hereditary syphilis.	. . . .

The age incidence is shown in the following table:

Under one	17	Seven to eight	3
One to two	7	Eight to nine	9
Two to three	5	Nine to ten	14
Three to four	8	Ten to eleven	5
Four to five	3	Eleven to twelve	4
Five to six	6	Over twelve	11
Six to seven	8		

Sex and Color.—There were 48 male children, of whom 5 were colored, and 52 female children, of whom 9 were colored. The number of colored children is, of course, too small to permit any conclusions as to incidence or localization of syphilitic disease in the eyes in negroes.

Pupils.—Nine patients showed pupillary inequality. In 5, R. pupil > L. pupil. In 4, L. pupil > R. pupil. In 9 patients the pupils barely reacted to light, and in 3 there was complete fixity. One patient showed marked hippus.

Muscles.—Two patients had convergent, 2 had divergent, concomitant strabismus. Alternating convergent strabismus was observed twice. Partial ptosis (unilateral) was seen once. A lateral nystagmus was observed in 3 patients; in 2 the oscillations were fairly rapid, but not constant; in 1 the rate of oscillation was at least 150 to the minute and constant. In 1 patient, a child nearly blind, there were typical searching movements.

Conjunctiva.—In no case was there a primary conjunctivitis. Conjunctival congestion was present only in patients with active keratitis.

Cornea.—Nineteen patients presented evidences of present or past interstitial keratitis. In 17 the disease was bilateral. The corneal disease was mostly of a mild type. Some patients who presented indubitable nebulæ had been so slightly incommoded that they, or their parents, denied that the eyes had ever been sore. A beginning bilateral keratitis was observed in a white girl aged three (No. 53). In No. 35 syphilitic destruction of the lower lid resulted in keratitis from exposure.

Descemet's Membrane.—In no case were deposits or any abnormality observed.

Aqueous.—The aqueous was slightly turbid in two cases of active iritis.

Iris.—Thirty-six patients had brown irides, 37 hazel, 20 gray, and 7 blue. There is, in my opinion, absolutely no connection between the color of the iris and hereditary specific infection. Four patients had mild iritis. In 2 the condition was unsuspected until the mydriatic, used to facilitate ophthalmoscopic examination, disclosed one or more synechiæ. In the other two there was moderate ciliary injection with cloudiness of the aqueous.

In one patient with an absolutely white eye mydriasis disclosed a synechia which represented an antecedent iritis which had never been recognized and had subsided without local or general treatment.

Lens.—The only abnormality noted was in No. 39, who had a small posterior polar opacity. The periphery of the lens was clear and permitted a good view of the normal eyegrounds.

Vitreous.—Nos. 9 and 78 presented a fine haze of the anterior part of the vitreous. No. 71 showed in one eye remains of the hyaloid artery.

Eyegrounds.—In the ophthalmoscopic examination great care was taken to secure as complete a picture of the eyegrounds as possible, which necessitated, in many cases, repeated examinations under mydriasis. The intraocular lesions of hereditary syphilis are so frequently situated peripherally that an examination confined to the region of the disc and macula would have failed to uncover characteristic ophthalmoscopic changes. The greatest difficulty was experienced with infants, who almost invariably cried and struggled when the light was flashed into their eyes. With the head controlled by the assistant, and the arms and legs firmly pinioned by the nurse, it was usually

possible to secure a satisfactory examination. After a short preliminary struggle the infant would become interested in the bright light of the electric ophthalmoscope, and perhaps a little hypnotized by it, and the examination would proceed in quiet. To secure a view of the periphery, a flashlight brighter than the ophthalmoscopic light would be held to the right, left, above, and below and repeatedly flashed. This manœuver usually succeeded in causing the eyes to rotate in the desired direction, and afforded a satisfactory view of the outlying regions of the retina.

Fifty-two of these 100 children presented undoubted pathologic eyeground lesions. Thirty-seven showed no intraocular lesion, but in a few of this group ophthalmoscopic examination was impossible on account of the density of the corneal opacity. There remain 11 "borderline" cases, which, while showing certain deviations from the normal, did not, in my opinion, present such indubitable evidences of intraocular pathology as to warrant their being placed in the first group. These "probably pathologic" cases presented such signs as undue pallor of the nerve-head without signs of true atrophy, hyperemia of the nerve-head without evidence of true neuritis, a diffuse haze of the nerve-head and surrounding retina without central or peripheral lesions, and a brown pigmentation of the macula without other ophthalmoscopic stigmata. There was hardly a single pathologic eyeground that did not present lesions of diverse types; in other words, mixed forms predominated. The attempt will be made to describe characteristic changes under appropriate appellations. These changes were:

1. Peripheral, sometimes central, punctate pigmentation.
2. Peripheral, sometimes central, punctate depigmentation.
3. Fairly numerous (10 to 30) small ($\frac{1}{8}$ to $\frac{1}{4}$ disc diameter), round, whitish areas bordered by gray pigment, often containing a small pigment dot in the center.

4. Small to large, irregular, retinochoroidal atrophic areas bordered by pigment.

5. Small to large masses of gray pigment, usually peripheral, irregularly disposed, and alternating with depigmented areas.

6. Disseminated retinochoroiditis.

7. Sclerosis of choroidal vessels.

8. Neuroretinitis punctata.

9. Retinal hemorrhages.

10. Optic nerve: (*a*) Papillary haze. (*b*) Pallid nervehead. (*c*) Optic neuritis. (*d*) Optic atrophy.

11. Vessels: Perivasculitis.

1. Peripheral and central punctate pigmentation coincides very closely with Type I of Sidler-Huguenin, and is comparable to Fig. 39 in Haab's Atlas of Ophthalmoscopy. Twenty-eight patients presented this picture. Tiny dots of brown or brown-black pigment are strewn fairly evenly over the retina. Sometimes the entire fundus is "peppered" —more frequently the distribution is confined to large peripheral areas. The individual dots are round or irregular in outline, and vary somewhat in size. Between the dots are minute yellowish-red spots.

These punctate brown dots are so characteristic that after a few cases have been observed it is hardly possible to confuse this picture with any other. As Haab has pointed out, the normal blond eyeground is often punctate with numerous fine gray dots which might be confused with the appearances just described. A point in differential diagnosis is that the syphilitic lesions can be seen with the inverted image, which is not true of the physiologic dotting. The syphilitic lesions, too, are darker, vary more in size, and are more numerous than the physiologic dots.

2. Peripheral punctate depigmentation. This type was much less common. It was observed in only three patients. It was seen typically in No. 93. The periphery of each

fundus presented numerous light-colored or even white circular dots. In this case there was no pigment dotting between the light areas. The fundus seemed to have been "rained" upon. In the other two patients these light-colored dots occupied one portion of the periphery, while the other portions were punctate with brown pigmentation.

3. Small round white areas with pigment center and border. This picture was seen in several patients, associated with brown punctations. In No. 20, a victim of cerebral syphilis and hemiplegia (blood and spinal fluid Wassermann, 4+), there were numerous, small, round, whitish areas with center and border lightly pigmented. These occupied the center of the eyeground. They gave the impression of being superficially situated, probably in the retina.

4. Retinochoroidal atrophy. Five patients presented large, irregular areas of dark, pigment-bordered retinochoroidal atrophy. These bore a striking resemblance to the single, unilateral or bilateral, peripherally situated areas often observed in adults who have never suspected the existence of an ocular lesion. May not a specific intrauterine choroiditis which runs its course be the explanation of many of these unsuspected lesions in adults?

5. Masses of gray pigment alternating with depigmented areas. This appearance was observed in 4 patients, most typically in No. 91. Each periphery was occupied by several large, approximately round, gray pigment masses, one-half to one disc diameter in size. These overlay the retinal vessels. Between them the retina was greatly deficient in pigment.

6. Disseminated retinochoroiditis was observed in 2 patients, most typically in No. 51. The temporal half of each fundus was occupied by half a dozen or more round, fluffy white areas of active retinochoroiditis. At the time of observation there was no pigment massing along the borders of the lesions.

7. Sclerosis of choroidal vessels. This rare anomaly was observed in No. 63. The sclerosis was confined to the area immediately surrounding the optic nerve, which was completely atrophic.

8. Neuroretinitis punctata was observed in No. 29. The nerve-head was moderately swollen, with very numerous pinpoint, glistening white dots occupying the edematous macula.

9. Retinal hemorrhages. Several minute retinal hemorrhages were observed in No. 28, a patient with well-marked optic neuritis. In No. 64 the condition of the vessels above the left fovea was suggestive of an antecedent hemorrhage.

10. Optic nerve. (*a*) Papillary haze. It was surprising to observe how frequently the optic nerve-head appeared slightly fogged, an overlying veil just sufficient to obscure the details of the disc and obliterate the clean-cut line of demarcation between disc border and retina. This obscuration occurred in some eyegrounds presenting no other abnormal appearances. (*b*) Pallid nerve-head. Nineteen discs, which presented none of the appearances of true atrophy, were included in this group. All these cases were in marasmic or anemic children: the pale disc was probably the intraocular expression of the general anemia. (*c*) Optic neuritis. If reference is made to the statistics emanating from Neumann's clinic, it will be seen that the claim is made that fully 80 per cent. of syphilitic nurslings have optic neuritis. The present series showed optic neuritis in only 8 patients, or 8 per cent. A quite common appearance in hereditary, as well as in acquired, syphilis is a brick-red disc, without swelling, obscuration of the margins, or vascular alteration. To classify such a hyperemic disc as an optic neuritis is, in my opinion, a serious error. The diagnosis of optic neuritis in children should not be made unless there are obscuration of the margins, slight swelling, and vascular engorgement. (*d*) Optic atrophy. Eight patients presented signs of optic atrophy. In 6 the atrophy affected both

nerves; in 2 it was unilateral. Three were partial atrophies, 5 were total. In 1 unilateral case the other eyeground was normal. In the other the fellow eyeground was involved, presenting a retinochoroiditis. In all of the cases the arteries were contracted and the lamina cribrosa was invisible.

11. Vessels. (*a*) Perivasculitis was observed in Nos. 6, 71, and 78. In the first two it occurred in eyes with optic atrophy. In No. 78 the eyeground was otherwise normal.

Serologic Tests.—As has been stated, no patient was admitted to the series who did not present at least a ++ blood Wassermann. At the time the ocular examinations were begun, about three years ago, it was customary to make serologic examinations of the spinal fluid only exceptionally, and for the most part only on hospital patients. At the present time the spinal fluid of nearly every syphilitic child is subjected to serologic and microscopic tests. For this reason the series includes only 48 spinal fluid Wassermanns, of which 16 were positive and 32 were negative. A positive spinal fluid Wassermann always indicates involvement of the cerebrospinal system.

Clinical Diagnosis.—Eighty-nine cases were diagnosticated as "hereditary syphilis"; 9 as "cerebrospinal syphilis"; 1 as "cerebral syphilis," and 1 as "syphilitic spastic paraplegia." Many patients were marasmic. Many developed complicating troubles, such as rachitis, bronchitis, bronchopneumonia, pertussis, poliomyelitis, tuberculosis, orthostatic albuminuria, diarrhea, arthritis, osteomyelitis, and chorea. Several were deficient mentally.

The results of this study point very clearly to the need of a systematic ocular examination of every syphilitic child. Such an examination may not have great importance from the standpoint of diagnosis, for in this respect the serologic test stands preëminent, but without it the clinical picture may be incomplete. As many of the eyeground lesions are situated

primarily in the periphery, it is imperative that treatment be instituted at the earliest possible moment in the hope of preventing an extension of the process to the peripapillary and macular regions. Even if the lesion be central, the outlook for useful vision will be better if the condition be early recognized and treatment controlled by frequent ophthalmoscopic examinations. If optic neuritis is found, it may be unwise to give salvarsan or any arsenical preparation, and to rely exclusively on mercury, at least until all inflammatory signs in the optic nerve-head have disappeared.

I am convinced that the dark-brown, punctate pigmentation is absolutely characteristic of the eyeground of a hereditary syphilitic. It must be differentiated from the gray punctation seen in many blond fundi, but this is a matter of no difficulty after a few of the syphilitic type have become impressed on the mind.

That occasionally this intraocular lesion may be the sole expression of inherited syphilis, or if others have existed they have been so insignificant that they have been overlooked, is illustrated by the following case:

A boy of five was brought to the hospital with fever and symptoms of meningeal irritation. The father was unable to account for the condition, as the child had always been healthy and there was no reason to suppose that he had been exposed to contagion of any kind. The clinical diagnosis was meningitis. I saw the boy in consultation and found a perfectly typical dark punctate pigmentation of the eyeground and ventured the opinion that the Wassermann on father and child would prove positive, which was actually the case. The child promptly recovered under neosalvarsan and mercury.

I have been on the lookout for this type of eyeground disturbance in adults, but have encountered it only twice: Once in a young man of twenty-one who showed corneal evidences of an old keratitis, and once in a fifty-year-old

hyperopic woman who presented no signs and gave no history of either inherited or acquired syphilis.

The virus of syphilis is deadly to young human life. Countless babies die before they have ever had a chance to live, and countless more eke out a miserable existence for a few years and then perish. So it is that very few syphilitic children reach adult life, and so it is that the characteristic intraocular lesions only rarely show in adults.

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REMARKS ON DIAGNOSIS AND TREATMENT OF LUETIC INVOLVEMENT OF THE OPTIC PATHWAYS.*

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INTRODUCTION.—I shall build my discussion on the subject of this paper around the following truisms: (1) The success of a treatment depends (*a*) how accurately and early we make a diagnosis, (*b*) how well we are able to treat, and (*c*) how thoroughly the patient carries out instructions. (2) Treatment will never equal prevention. The second part of this paper reports on personal successes and failures in a series of cases of luetic involvement of the optic pathways.

I. EARLY DIAGNOSIS.—The subject of diagnosis of disease of the optic pathways has progressed at a rate always in direct proportion with discoveries of new methods of examination of the visual apparatus. Ophthalmoscopy, perimetry, the

* Candidate's thesis for membership, accepted by the Committee on Theses.

measurement of acuity of vision, of color and light sense, the study of the pupils, the clinical history—our five main means of establishing a diagnosis, though far from having reached a degree of ideal precision, constitute a pretty good armamentarium to furnish us more or less satisfactory information for the establishment of an early diagnosis. And yet early diagnosis of syphilis of the optic pathways is not made except in an infinitesimal percentage of cases. Since the advent of the new era of scientific syphilography, based upon the discovery of the spirochæta pallida, the routine examinations of the blood and spinal fluid, and inoculations in animals, a number of facts of great importance to the clinician have been established. One is that the entire organism is invaded by the spirochætæ already during the secondary stage of lues. Another fact is that about 20 to 25 per cent. of syphilitics show evidence of an involvement of the central nervous system during the early stages of infection. A third fact is that syphilis, active or latent, is present in a large proportion of the human race.*

Having learned this lesson, ophthalmologists necessarily will have to ask themselves: How frequently and how early are the cranial (the second, third, fourth, fifth, sixth, seventh, eighth) nerves, concerning directly or indirectly our own specialty, involved by syphilis? How early should we attempt to detect this involvement? It is not necessary to argue on the importance of these questions. The very heart of ophthalmology is involved in them. Taking only one phase of the subject, the second cranial nerve, we are not prepared to answer to-day with any degree of accuracy how frequently and how early it is involved in syphilis. Studies on this question, made in the era preceding scientific syphilog-

* Major Vedder found 17 per cent. of syphilitics among the recruits of the United States army. Steinert and Flusser have found, among 2533 children, 5.7 per cent. afflicted with inherited syphilis. Symmers found evidence of syphilis in 6.5 per cent. of 4809 postmortems, while A. S. Warthin, using as criterion the microscopic changes of the tissue, found, in 750 autopsies, 300 cases (40 per cent.) with evidences of syphilis.

raphy, are only partially reliable, because the means of diagnosis of syphilis were insufficient. Nowadays, when we possess the means of demonstrating the presence of spirochætæ in the lesion, and when we can make use of the five laboratory reactions, blood Wassermann, spinal-fluid Wassermann, cell count, Lange, and globulin, in addition to the old clinical examination, our diagnosis is more reliable and the answer to the above questions may be considered nearer to the truth.

How early should we attempt to detect an involvement of the second cranial nerve in a luetic? As early as the primary lesion makes its appearance; and the examinations should be repeated at regular intervals during the entire time the patient is under the observation of the physician. If this attitude should be taken by ophthalmologists, a number of important changes would take place. In the first place, we would obtain definite data regarding the earliest period and frequency of appearance, the types of optic nerve lesions, their course, prognosis, and types of response to treatment in patients diagnosticated as syphilitic by our present methods. In the second place, we would do our share to stimulate the general practitioner and the syphilographers to watch the cranial nerves, and particularly the second nerve, from the very beginning of the infection, a thing which is not done but with very rare exceptions. In the third place, we would gain valuable information regarding the future of the nervous system of that particular individual, and we would be able to tell when to stop medication or to proceed with a new line of treatment. In the fourth place, it would prevent blindness.

The conception of the words "early diagnosis" of syphilitic involvement of the visual pathways, as it was meant in the prescientific era of syphilography, was necessarily different than that we have to-day. Then it meant the detection of fundus, perimetric, and other disturbances, as soon as the patient had some complaint about his vision, usually years

after the infection had taken place. Now it means the search, beginning already in the early secondary stage of lues, for symptoms and changes, possibly too slight to be noticed by the average patient. Then the "early diagnosis" was in reality a "too late" diagnosis of very little practical importance, because the process was old and the changes advanced; now the early diagnosis is of great practical importance, because the process is searched and may be discovered at its inception when the changes are not irremediable.

For the past three years I have tried to apply these ideas of "earliest diagnosis" by joining the workers in the Department of Syphilis of Vanderbilt Clinic of the College of Physicians and Surgeons, Columbia University, and I made routine examinations of the patients with primary, secondary, and tertiary lues. Though it is too early to report on the findings of these investigations, one thing can be here safely stated, namely, that involvement of one or several cranial nerves, directly concerning the visual apparatus, was many times found without the patient knowing or complaining about it. In the old prescientific era of syphilography these conditions were invariably passed unnoticed. The importance of this earliest diagnosis from the therapeutic and prognostic point of view is self-evident.

II. ACCURACY OF DIAGNOSIS.—There is no limit to the number of pitfalls we are exposed to when we are called upon to make a diagnosis of a lesion of the optic pathways of syphilitic nature. The first and most dangerous of all is the Wassermann blood test. It has almost become an established tradition that a patient with, say, an optic neuritis or optic atrophy, and a 3 or 4 plus Wassermann blood reaction, must have a syphilitic optic nerve lesion. Nothing may be further from the truth than this, because: (1) One single blood test, made by one laboratory, can never be depended upon for a final decision; (2) the condition may be due to an

entirely different cause than syphilis, although the patient may be syphilitic; (3) the condition may be due to syphilis plus one or several other causes. One of the most difficult problems in medicine, and especially in ophthalmology and neurology, is the diagnosis of a non-syphilitic condition in a patient with syphilis. From the therapeutic point of view the accuracy of the diagnosis may spell complete failure or success. The reports of the following two cases will suffice to make this point clear:

The first case is that published by Dr. A. Knapp*: A man aged thirty-six, luetic, with 4 plus Wassermann and bilateral partial optic atrophy, with vision progressively failing in spite of anti-syphilitic treatment. Later on, *x*-ray of the skull reveals a bone absorption in the sella turcica and anterior fossa, suggesting the presence of a mass lying in the sellar region, partly in the anterior, partly in the middle, fossæ. The patient died after an exploratory operation, and at postmortem was found a large epithelioma in the frontal lobe, springing from the dura on the convexity and from the adjoining part of the falx.

My own case, a man, aged fifty-four, had been infected with lues in 1904 and began to notice failing vision in 1915. Blood Wassermann 4 plus. The diagnosis of progressive bilateral optic atrophy of luetic nature was made by one of the most distinguished ophthalmologists of this country and abroad, and in spite of a careful and sustained antiluetic treatment vision continued to fail. When the patient came under my observation in June, 1917, he had a bilateral absolute central scotoma; V.R.E., 15/100; L.E., 15/70 with correction. A careful inquiry brought out a history of excessive drinking and smoking. The discontinuance of this abuse and the routine treatment with K. I., strychnin, and hot baths, improved vision to right, 20/100; left, 20/70, and reduced the large absolute central scotoma in the right to a

*Archives of Ophthalmology, January, 1918.

small, relative paracentral scotoma which enabled him again to read with ease ordinary newspaper type. This case illustrates how easily a syphilitic patient may be condemned to antiluetic treatment if he has a 4 plus Wassermann blood reaction. Here we had to deal with a toxic amblyopia, plus syphilis, which naturally did not yield only to antiluetic treatment.

A great stumbling-block in the path of accurate diagnosis is the presence of another disease besides syphilis. In such cases the question immediately arises: "Is the visual lesion due to syphilis alone, to this other disease alone, or to both together?" A schematic summary of conditions to be investigated, as I desire to keep before my mind, is as follows:

First: Acute or chronic sepsis from foci of infection in nasal sinuses, tonsils, ears, teeth, gall-bladder, appendix, genitals, intestines, etc.

Second: Acute or chronic toxemias from disturbances of digestion, nutrition, and of elimination, of the endocrine system, and of lead, arsenic, alcohol, etc.

Third: Acute or chronic trauma, emotional or physical or occupational, like aneurysms, empyema of nasal sinuses, periostitis of optic foramen, etc.

Fourth: Heredity and congenital conditions.

Only after having exhausted this schematic plan of investigation, which is by no means an ideal one as far as completeness is concerned, are we justified to say that the optic lesion we are dealing with is of purely syphilitic, of mixed, or of non-syphilitic nature. No matter how complex and almost hopelessly difficult such a search of the human organism appears to be, it cannot be denied that there is no other way of reaching an accurate diagnosis.

Leaving to the internist and other special workers the endless amount of clinical and laboratory work necessary for the elucidation of such a diagnosis, we should not be backward in

adopting, as our own, new methods of examinations which contribute toward accuracy of diagnosis in ophthalmology.

The Spinal Fluid.—One of the most valuable additions to our diagnostic armamentarium of late years is the examination of the spinal fluid. The information furnished by this examination cannot be obtained in any other way. It has been definitely shown that the central nervous system is invaded early at the beginning of the secondary stage of lues. I. Fordyce found that 20 to 25 per cent. of syphilitics show pathologic changes of their spinal fluid during the first year of infection. H. Swift thinks that 33 per cent.; Ravaut that 67 per cent.; Gennerich even that 90 per cent. of syphilitics show changes of their spinal fluid during the early stage. The most characteristic evidence of the luetic invasion of the central nervous system is found in the examination of the spinal fluid. There are patients who have for years marked syphilitic changes of the spinal fluid and no clinical symptoms whatsoever. B. C. Corbus has seen 6 cases of primary lues, 33 per cent. of cases with secondary lues, and 40 per cent. of cases with tertiary lues with no neurologic symptoms, but with marked luetic changes of the spinal fluid. It is a frequent occurrence to find luetics with negative blood Wassermann and positive spinal-fluid findings. Consequently, since the spinal fluid may show evidence of lues, not discoverable clinically or by blood examinations, since it shows changes during the earliest as well as in all stages of neurosyphilis, even before the symptoms of neurolues make their appearance, we have to utilize the spinal puncture in every case of lues with manifestations in the central nervous system or cranial nerves.

We could classify the information obtained from a spinal-fluid examination from three points of view: diagnostic, prognostic, and therapeutic.

The diagnosis of luetic changes present in the spinal fluid is made by examining it (*a*) For increase in the number of

cells; (*b*) for the presence of globulin; (*c*) Wassermann reaction; (*d*) Colloidal gold solution reaction (Lange). It would be irrelevant to enter into the discussion of the meaning of each one of these changes and of their variations. But a schematic summary of the most usual clinical combinations, as found in the class of patients we deal with, would lead to a better appreciation of this part of the subject.

A negative blood Wassermann does not exclude syphilis:*

(1) The spinal fluid may be positive and the blood positive.
(2) " " " " " positive " " " negative.
(3) " " " " " negative " " " positive.
(4) " " " " " negative " " " negative.

Positive Wassermann of spinal fluid means active or latent lues of the central nervous system. In certain types of cases, like treated general paralysis, the spinal fluid is always positive and the blood may be negative. Aborted tabes, with absent patellar reflexes and Argyll-Robertson pupils, but otherwise clinically well, have negative spinal fluid and negative serum.

1. The Wassermann reaction of spinal fluid may be strongly positive and respond to treatment by becoming weaker and later on negative.

2. The Wassermann reaction of the spinal fluid may be strongly positive and not lessen in intensity in spite of the treatment (Wassermann fast). Wassermann-fast spinal fluid is a strong indication of taboparesis or general paresis. To my mind, optic nerve lesions, with the ophthalmoscopic appearance of simple atrophy, in patients with "Wasser-

* Symmers, Darlington, and Bittman found, in a large amount of material at the Bellevue Hospital, New York: *a*) Negative blood Wassermann in vivo in 31 to 56 per cent. of cases with characteristic anatomic signs of syphilis at postmortem. (*b*) Fouss relates that, in his experience with 243 cases of untreated syphilis, he found 10 per cent. giving a negative blood Wassermann. Gordon found that only 60 to 70 per cent. of neuroluetics have a positive blood Wassermann reaction. B. C. Corbus has seen several cases with negative blood Wassermann for eighteen to twenty-four months without treatment and positive spinal fluid findings. For convenience sake we will call positive or negative the spinal fluid or blood when showing evidences or no evidences of lues.

mann-fast" spinal fluid, belong to a clinical type distinct from optic nerve lesions with the same ophthalmoscopic appearance, but with a "Wassermann not fast" spinal fluid.

The increase in globulin is the most constant finding in neurolues, but is not pathognomonic. The globulin present in the spinal fluid may be in very small, moderate, or large quantity. The origin of the globulin and its pathologic meaning are not well known. Nonne and Fordyce think that its presence means an organic disease of the brain. It is usually the last to disappear after treatment. I found it always present when the Wassermann reaction was positive and when the number of cells was increased.

Pleocytosis.—The increase in the number of cells in the spinal fluid may be small (10 to 20 cells), as I usually found in the taboparetic optic atrophies, moderate, or marked. The presence of pleocytosis means a meningeal irritation or inflammation. The number of cells is in direct proportion to the intensity of the meningeal irritation. Lesions of the optic pathways with slight pleocytosis and marked increase of globulin are mostly parenchymatous, while those with marked pleocytosis and much or little globulin are mainly meningitic.

The "Lange" or "colloidal gold solution" reaction may be negative, luetic, or paretic. The negative "Lange" is no decisive proof against the existence of lues of the central nervous system. The luetic type of the Lange reaction is indicative of lues affecting the meninges or interstitial nerve tissues. The paretic type is very suggestive of general paresis, present or impending. A great majority of syphilographers and neurologists believe that a spinal fluid with a paretic type of Lange reaction which cannot be reduced by treatment is a very strong evidence of general paresis. If, in addition to the paretic "Lange," the spinal fluid exhibits a Wassermann "fast" reaction, the diagnosis of general paresis or taboparesis is very much strengthened. In optic path

lesions the character of the colloidal gold solution reaction varies according to the type of cerebrospinal lues the patient is affected with. My cases of malignant, progressive, luetic optic atrophies had a strongly positive Wassermann and a persistent, non-reducible, paretic Lange reaction.

Do we, as ophthalmologists, get any definite information from the examination of the spinal fluid, and if we do, what is it?

The information we receive is definite:

1. It shows us whether we deal with a luetic involvement of the central nervous system (negative spinal fluid in a non-treated patient is a strong evidence against it).

2. It gives us a clue as to about what pathologic type of lesion of the optic path we are dealing with. The marked pleocytosis, the reducible plus Wassermann and luetic Lange, point to a meningitic process; the Wassermann fast, paretic Lange, absence of pleocytosis, and marked globulin increase point to a parenchymatous process.*

3. It informs us what treatment to institute and how far the nervous system responds to the treatment.

4. It furnishes us a good deal of information about the prognosis, the parenchymatous type being very much more unfavorable than the meningitic or interstitial type.

REMARKS ON PROPHYLAXIS AND TREATMENT.—A few years ago prophylaxis of luetic involvement of the optic pathways meant only one thing - avoiding the infection. Now, since the early diagnosis of lues was made possible by Schaudinn's discovery of the spirochæta, we possess in the intensive and prompt treatment (abortive) one more means of preventing it from invading the central nervous system. A second and very important advance in the direction of prophylaxis dur-

* Before the Wassermann and Lange reactions of the spinal fluid were in use, Southard found on postmortem examinations of 41 patients, clinically diagnosed as paretics, that 15 per cent. were wrongly diagnosed. On the other hand, Darling, with 168 cases, found that the addition of the serologic picture to that of the clinical study brings up the accuracy of diagnosis to almost 100 per cent.

ing the last few years was made by the utilization of Quincke's method of spinal puncture. The routine examination of the spinal fluid of all the luetics in the early secondary stage points out to us those who have their central nervous system invaded. This class of patients, singled out at the beginning of their neurosyphilis, get spinal attention and treatment until not only their blood, but also their spinal fluid, shows no more abnormal reactions.* In this way we may arrest the process in its beginning and prevent serious damage to the central nervous system and optic pathways. In other words, the treatment for the prevention of lues of the optic paths can have some hope of success only when the infection and the invasion of the nervous system are treated at the earliest possible moment.

Having failed to prevent, the question to be considered next is:

How well do we understand the proper treatment of the optic pathways? The answer is: As well as we know how to treat syphilis in general and that of the central nervous system in particular.

Does the treatment of neurolues differ in any manner from that of syphilis in any other part of the body? Yes. The last few years have developed a new method of treatment of neurolues, consisting of intraspinal and intracranial medication in addition to the general antiluetic treatment by salvarsan, mercury, and iodids.

Is there unanimity of opinion among neurologists and syphilographers regarding the indications and efficacy of intraspinal and intracranial medication? No. There are yet a large number among them who do not believe that

* Dr. I. Rosen, Chief of Clinic of the Department of Syphilis at the Vanderbilt Clinic, in a personal communication, told me that he has seen several cases of primary lesions with demonstrable spirochætæ which never developed secondary skin eruptions, blood, or spinal-fluid reactions. He thinks that prophylaxis of neurolues is possible in patients treated intensively while the infection is still in the primary stage.

intraspinal medication obtains results superior to the general treatment.

What are the arguments advanced in favor of spinal medications? The arguments are:

First, There are cases of neurosyphilis, like certain types of tabes and cerebrospinal lues, which do not improve either clinically or serologically by general treatment, but which show rapid improvement during spinal medication.

Second: There are other cases of neurolues which improve during general treatment only up to a certain point, but get well after the spinal medication.

Third: Other cases respond promptly to general treatment, but show frequent recurrences. These become arrested by adding the spinal method of treatment.

Fourth: There are cases of neurolues which cannot stand mercury or salvarsan or either. They show anaphylactic or toxic symptoms, dermatitis, jaundice, etc. Such patients are entitled to spinal treatment and many of them do well with this method.

What reasons are advanced by those like Sharp, Hammond, Wardner, and myself, who recommend intracranial medication of cerebrospinal lues in addition to general and spinal treatment? There are cases which do not improve by general or spinal treatment and which are entitled to the application of the therapeutic agent directly where the pathologic process exists—in the cranium.

Why does the general treatment not act in some cases of syphilis of the brain or of the optic pathways? Because the blood-vessels and tissues surrounding them are impervious to medication.

Why, then, is spinal medication not sufficient in such cases? Because: (1) In many there is a diffuse adhesive process between the meninges and spinal cord and brain. Spinal medication has no chance of diffusing to the spinal fluid and reaching the cranial contents. (2) Even if there were no

mechanical obstacles, like exudates and adhesions, to the diffusion of the medication upward, my own experiments, as well as those of others, such as Sharp, Tilney, etc., have shown that fluids injected into the lower parts of the spinal canal do not extend into the cranial cavity beyond the medulla oblongata and pons, consequently they do not reach the optic region of the nerves.

If spinal medication does not reach the brain substance and optic nerves, how do we explain the good results obtained by this method in a certain number of luetic intracranial lesions? My explanation is that it is not so much the medication as the meningeal reaction, the active hyperemia, which produces the beneficial effect. In some cases this reaction extends all the way up to the brain and to the most anterior cranial nerves; in others it does not. In the former we get results; the latter need cranial treatment in order to obtain the reaction in the tissues we wish to medicate.

What are the arguments advanced by those who do not believe in intraspinal and cranial treatment? These are:

First: A few cases have been reported which developed transverse myelitis with paraplegia, disturbances of the function of the bladder and rectum, and even death following spinal medication.

Second: Results obtained are not better.

Third: The treatment is painful, followed sometimes by very severe headaches, lasting from one to fourteen days.

Fourth: Some patients object to the treatment.

Fifth: The salvarsan or mercury contained in the serum to be introduced into the spinal canal is too small to have any spirochætecidal action.

Sixth: When introduced into the spinal canal, drugs pass rapidly into the general circulation and consequently have no time to have a therapeutic action.

What do the spinal treatment advocates answer to the anti's?

First: The cases of myelitis following spinal medication are extremely few in number, if we consider the thousands of injections done with impunity. Granting that no mistakes in dosage and technic have been committed, which still has to be proved, we cannot deprive hundreds of patients of a beneficial treatment because of this minute percentage of danger.*

Second: The results obtained by spinal medication are better in a certain group of cases. It is just this class of patients which is not responding to general treatment, in which the serology of the spinal fluid is not influenced by intravenous and muscular injections, that the spinal treatment is clearly indicated.

Third: Spinal treatment is painful, and the headaches are sometimes intense, but bearable. They are absent if the patient keeps to bed and quiet for a few days. The first few treatments are the most unpleasant for the patient; later on he becomes used to them, and the pains are very much less intense and of short duration.

Fourth: The objections of some patients to the treatment is explainable only by their ignorance as to the gravity of their trouble and as to the possibilities of saving their remnant of vision by spinal medication.

Fifth: I do not believe that the small amounts of mercury or salvarsan contained in the serum to be injected intraspinally have a great spirochætecidal action, but I believe that they cause a beneficial reaction of the tissues. The results are what count; some patients improve.

Sixth: True enough, drugs are absorbed rapidly by the blood-vessels of the spinal canal, but before this happens the reaction of the tissues takes place.

Supposing that the reader is yet impartial to this con-

* Were we to reason this way, no surgical operation could be undertaken on account of the possibility of an unfavorable outcome. Dr. I. Rosen, who has made thousands of spinal injections, has never had any of the complications just mentioned. My limited experience agrees with that of Rosen.

troversy between the pro and the antispinal therapeutists, what line of treatment should he follow, when he gets a patient with a luetic involvement of the optic pathways?

The answer must be subdivided into several parts:

First: To make a strictly accurate diagnosis, recognizing and eliminating or treating all the other factors which may cause the lesions.

Second: To ascertain that there is yet present an active process. End results of a condition which has come to a standstill need no treatment. A partial optic atrophy with no tendency to progress, with negative findings in the blood and spinal fluid, and no clinical evidence of an active neurologic disease, should be watched but not treated.

Third: Patients with a vision reduced to counting fingers at a few feet, with very poor fields of vision and atrophic optic discs, should not be treated by any hopes of encouragement.

There remains the group of cases with 20 200 vision or more, with a fairly good field and in good general condition, which belong to the ophthalmologic practice. These cases are to be classified according to the type of neurolues and type of optic nerve lesion they are affected with.

The optic pathways, just as the rest of the central nervous system, exhibit a variety of distinctive types of lesions, which, for therapeutic purposes, could be temporarily classified in the following schematic manner:

A. The acute optic neuritis and papillitis of the secondary stage.

B. The reaction papilloedema of the secondary stage, the so-called neuro-recurrence.

C. The optic neuritis and papillitis and optic chiasm infiltrations of the tertiary stage.

D. The retrobulbar neuritis type.

E. The optic atrophies; (*a*) Following papilloedema, papillitis, optic neuritis; (*b*) retrobulbar neuritis; (*c*) optic

chiasm involvements; (*d*) endovasculitis of the optic pathways; (*e*) endarteritis of the retinal blood-vessels and an ascending degeneration from a chorioretinal condition; (*f*) the acute, the subacute, and chronic types of primary simple optic atrophy, taboparetic; (*g*) the various mixed types.

It would lead us too far astray were we to reason out the whys of this classification. Suffice it to say that therapeutically it is of greatest importance to have a clear idea of (*a*) Whether we deal with a taboparesis, cerebrospinal lues, or a vascular case; (*b*) what type of optic pathway lesion the patient has; (*c*) in what stage of lues the optic pathway became involved.

The indications, the dosage, the frequency of treatments, and the method of administration are quite different not only in each type of neurolues, but also in each type of optic path lues.

For instance, in a case of papilloedema or papillitis occurring during a course of intravenous salvarsan injections, the indication is to continue persistently with mercury and salvarsan—the condition clears up. If we stop for fear of increasing the papilloedema, we run the danger of letting the syphilitic process go on unchecked to fatal termination, that is, atrophy.

A case of optic neuritis in the secondary stage has to be treated along similar lines, possibly more energetically. The extent of the condition is greater, the sheaths of the nerves are usually primarily involved, and the question of spinal medication in addition to the general treatment has to be considered.

The optic neuritis, papillitis, and optic chiasm infiltrations of the tertiary stage are an entirely different therapeutic problem. Here we have to deal with the tissues, where a series of biologic changes took place during the years of symbiosis with the spirochætæ or their toxins. I fail to see

how we could expect that this sort of modified strain of microörganisms should be attacked by salvarsan and mercury in the same manner as the fresh spirochætæ of the secondary stage. And it does not. Neither could we expect that tissues, whose resistance to the toxins or spirochætæ has been gradually breaking down or built up during years of struggle, should be readjusted by the same chemicals and methods as those tissues which are just at the beginning of the infection, as in the primary and secondary stage.

We are in great need of knowing the exact indications for dosage, frequency, and method of administration of our therapeutic agents, and future experience will have to develop this knowledge. We need more than this. We need new methods and better therapeutic agents.

The retrobulbar neuritis type, rare, would require not only the routine antispecific treatment, but also the serious consideration of a decompression operation, like trephining of the sheath of the optic nerve, if the course of the disease is seriously threatening a permanent extinction of the vision.

Finally the question of optic atrophies.

To my mind a clear understanding of the pathologic condition which is causing the atrophy of the optic nerve is absolutely necessary in order to decide what therapeutic road to follow.

Cases of simple optic atrophies, with a fulminant course, are surely a small but distinctive group. There is not one minute's time to lose. They are acute atrophies, which absolutely refuse to respond to the old routine treatment. This group of acute optic atrophies is to be handled along entirely different lines than any of the other types of atrophies.

The optic atrophy with visible changes of the blood-vessels on the disc and retina should have a different treatment: general medication, like small doses of salvarsan intravenously, gradually increasing doses of iodids over a long period of time, and cautiously administered soluble

salts of mercury injections, together with a special hygiene sparing the cardiorenovascular system.

Frank neuritic optic atrophies, originating from an optic meningitis, need energetic general antisyphilitic treatment and also spinal or, if necessary, cranial treatment.

As we see, it is therapeutically meaningless to say "optic atrophy" without mentioning the kind of atrophy we are dealing with. I wish to emphasize that I consider the above classification and schematic outline of indications as only an attempt to make some sort of order in the maze of vague ideas I have on this subject. I do not doubt that most of the readers will modify and improve upon this attempt, the incompleteness of which impresses me at least as much as anybody else.

REPORT OF CASES.

The following cases are selected from a larger number and are reported here because they have been under observation for two or three years, a reasonable time to furnish an idea as to their course and termination. They represent the most frequent types mentioned in the first part of this paper, meningitic interstitial, vascular, and taboparetic, and illustrate how little in some, how much in others, therapeutic attempts may interfere with the march of the syphilitic process toward extinction of vision.

CASE I.—January 23, 1917. Isy A., aged thirty-five years, tailor. Tabetic optic atrophy. Luetic infection fifteen years ago. Patient complains that the right eye has been blind for the past five months and that the left eye began to blur a few weeks ago. V.R.E., counting fingers at three feet; L.E., 20/30+. Examination reveals both optic discs atrophic; pupils unequal, miotic, Argyll-Robertson. The spinal fluid had 50 cells, globulin+, Wassermann 4+, and a paretic curve (colloid gold reaction).

The tongue deviates slightly to the left; hypalgesia over both malleoli; Achilles reflex diminished, left; absent, right. Slight accentuation of the second aortic sound.

During the first two weeks of treatment with potassium iodid, strychnin, mercury, and small doses of salvarsan intravenously and intraspinally, the vision went down to "hand movements" in the poor eye and 3/200 in the good eye. The field of vision was so much reduced that he had to be led around.

Under such desperate circumstances intracranial treatment was resorted to on February 15, 1917. The next few days after the treatment the vision diminished to only perception of light. Small intravenous and intracranial injections of salvarsan were kept up and the vision began to pick up so that four weeks after the first intracranial treatment he was able to call alone at my office from a distance of about twenty-five blocks and even went alone to the hospital, changing cars and crossing very busy avenues. His field became larger and his acuity of vision on March 20, 1917, was 20/200. But the improvement lasted only a few weeks. It began to deteriorate gradually, and in April, 1917, the vision of the left eye was 4/200, and the following month he could only count fingers at three feet. Later on he began to have generalized convulsions; his vision went down to zero in the left eye and hand movements in the right eye, and in December, 1918, he had to be taken to an asylum on account of mental disturbances. The findings in the spinal fluid were as follows:

	CELLS	GLOBULIN	WASSERMANN	LANGE
January 28, 1917.....	50	+	++++	....
February 7, 1917.....	..	....	++++	Paretic curve.
Intracranial treatment begun on February 15, 1917				
February 15, 1917.....	50	3+	++++ 0.2 c.c.	Paretic.
March 12, 1917.....	0	0	++++ 0.2	Paretic.

The blood-serum Wassermann remained 4+ throughout. The fields of vision much contracted above, to about 10 to 15 degrees from fixation point, gradually diminished until cranial treatment was administered, then improved for several weeks.

Remarks.—This patient is a taboparetic with an acute atrophic process in both optic nerves. The rapidity of

diminution of vision in spite of and during the general treatment, the marked temporary improvement of the vision and of the general condition after the first cranial treatments, and the final complete failure are the outstanding features.

CASE II.—Alb. B., aged thirty-nine years, insurance agent. Tabes with bilateral simple optic atrophy. Luetic infection denied. The right eye became blind during August–November, 1914, and the left eye began to fail some time later. In February, 1915, when he first came to the Eye Department of the Vanderbilt Clinic, his vision in the left eye was 20/100; glasses could not improve it; right eye, blind. Examination in February, 1916, revealed bilateral simple optic atrophy; rigidity of the pupils to light and to accommodation (?); absence of patellar reflexes; Achilles diminished. Field of vision contracted concentrically to about 40 degrees all around, with a marked indentation below and nasally. Blood, 4 + Wassermann; spinal fluid, 4 +; 16 cells; ± globulin; luetic curve. V. R.E., blind; L.E., 15/100. After a course of 31 spinal injections of salvarsanized serum, 11 intravenous injections of salvarsan, 21 muscular injections of mercury, given during a period of about two years, his vision was found to be 5/100, and the patient complained that he felt his sight was diminishing steadily. The intracranial treatment was begun in February, 1917. He received three injections of salvarsanized serum, ½ to 1 mg. of salvarsan to the dose, and his gradual loss of vision was arrested for about three months. Then it began to deteriorate again, and by February, 1919, he was blind in each eye. Mentally normal.

BLOOD AND SPINAL FLUID FINDINGS.

	BLOOD	CELLS	GLOBULIN	WASSERMANN	LANGE
1915	4+	..	..	..	..
October, 1916	1+	16	±	4+ 1 c.c.	Luetic curve.
December, 1916	..	3	±	4+ 0.6 c.c.	Luetic.
February, 1917	..	..	..	4+ 0.6 c.c.	Luetic.
March, 1917	..	..	..	4+ 0.6 c.c.	..

The field of vision of the left eye contracted steadily, first below and nasally, then the temporal part of the field began

to lose ground, the scotoma first crossing the point of fixation.

Remarks.—This patient is a tabetic who developed an acute process of optic atrophy, losing rapidly the vision in the right eye. It seems that the process was twice temporarily arrested—first, during the general and spinal treatment for about twenty-one months; second, during the three months of cranial treatment.

CASE III.—Pet. K., aged forty. Cabinet-maker. Cerebrospinal lues; bilateral optic atrophy (neuritic). Vision began to fail in the left eye some time in August, 1915, and in the right eye a few months later. In December, 1915, he had to give up work on account of his poor sight. In his personal history we find headaches, severe and continuous for three weeks, ten years ago; rheumatism in back and hand. Wife had four miscarriages and one living child. The examination, November, 1916, gives the following findings: Slight weakness of the right side of the face; diminished reflex of left biceps and each triceps; poor coördination of arms (pointing finger to finger); absence of patellar reflexes; suspicious right Babinski, Oppenheim, and Gordon. Spinal fluid, 4 + Wassermann (0.6); Lange, paretic; cells, 4; globulin, 3+. V.R.E., hand movement above, temporally and nasally. V.L.E., L. P. Pupils unequal, moderately dilated, rigid to light and accommodation. Fundus: Bilateral optic atrophy (neuritic). Treatment: Having had potassium iodid and strychnin, mercury and salvarsan for more than one year before he came under my observation, without any change in vision, the intracranial treatment was decided upon. First treatment November 21, 1916. Cranial treatments were given on December 1, December 19, 1916; February 1, March 14, April 20, 1917. The vision began to improve slightly after the second injection, when he could count fingers at five feet distance with his right eye and see hand movements with the left eye. His field improved so far as to give him the possibility of walking about in the room and street for some distance without bumping into objects. April 28, 1917, V.R.E., counting fingers at four feet; L.E., hand movements. The vision remained slightly improved until September, 1917, when with the right eye he could count fingers at four feet; with the left, at six

inches. Soon after the vision began to fail again, and in November, 1918, he could see hand movements at one foot with the right eye; at six inches with the left eye. The field of vision, restricted to the upper, lower, and nasal parts, improved somewhat when the acuity of vision was better.

BLOOD AND SPINAL FLUID FINDINGS.

	BLOOD	SPINAL FLUID	CELLS	GLOBULIN	WASSERMANN	LANGE
May, 1916.....	2+	..	9	..	4+0.6 c.c.	Paretic.
November, 1916.	..	..	4	3+	4+0.6 c.c.	Paretic curve.
February, 1917..	..	..	0	0	..	..
April, 1917.....	..	..	6	—	..	..

Remarks.—This patient with cerebrospinal lues and descending neuritic optic atrophy showed unmistakable signs of temporary slight improvement after cranial subdural injections of salvarsanized serum.

CASE IV.—L. Z., aged thirty-three years. Cerebrospinal lues. Bilateral optic atrophy (neuritic), with marked retinovascular changes. Left eye blind since October, 1915; the right eye began to fail gradually and steadily soon (?) after. History of chancre fifteen years ago. Loss of sexual power six months ago. Everything else in family and personal history negative. Examination October 27, 1916, reveals: V.R.E., 10/100; with correction, 20/100; L.E., hand movements. Pupils: Small, irregular, unequal, rigid to light and accommodation. Fundus: Bilateral, simple optic atrophy with marked sclerosis of the retinal arteries. Blood Wassermann, 4+; spinal fluid Wassermann, 4+ (0.2 c.c.); cells, 14: globulin, 2+; Lange, paretic curve.

Course of vision and treatment: After having received potassium iodid and mercury by mouth, 8 spinal injections of salvarsanized serum, 10 intravenous injections of salvarsan, and 9 intramuscular injections of mercury, his vision in the right eye slightly diminished to 15/100 (with correction), and in the left eye, 0. The intracranial treatment was given once in February, 1917, and vision in March, 1917, was found to be 20/70 for the right eye, the left eye remaining blind. The vision remained the same until June, when the patient

was taken to an asylum on account of sudden generalized convulsions and mental disturbance.

The field of vision, contracted above and temporally, remained the same during the entire time the patient was under observation.

BLOOD AND SPINAL FLUID FINDINGS.

	BLOOD	CELLS	GLOBULIN	WASSERMANN	LANGE
October, 1916	4+	..	..	..	..
November 4, 1916	..	14	2+	4+0.2 c.c.	..
November 15, 1916	..	30	3+	4+0.6 c.c.	Paretic.

Remarks.—This patient, with cerebrospinal lues and neuritic optic atrophy with marked retinovascular changes, showed a temporary improvement, or at least an arrest of the process of degeneration of the optic fibers, after the cranial treatment.

CASE V.—Rose Sol., aged twenty-nine years, cook. Cerebrospinal lues and simple optic atrophy with sclerosis of retinal blood-vessels. Luetic infection, probably after marriage, twelve years ago. Vision began to fail in right eye in July, 1915. Came under observation in July, 1916, when V.R.E., 15 200; L.E., 20 20, with correction. Neurologic examination revealed right knee-jerk diminished; Achilles reflex weak on both sides. Pupils unequal, Argyll-Robertson reaction.

Treated with strychnin and potassium iodid for six months, during which time the vision of the right eye diminished to 5 200; the left to 20 70. Received since January, 1917, 4 spinal injections of salvarsanized serum, 4 intravenous injections of salvarsan, 30 cg. each, and 4 mercury intramuscular injections. The vision continued to fail during this treatment, and at the end of the course she had but light perception with the right eye and 10 200 with the left. Intracranial treatment on July 3, 1917. The vision continued to diminish, and about five months later was light perception.

The fields of vision were contracted concentrically to about 40 degrees all around in September, 1916. Then, dur-

ing the next two months, the right field retracted below to the horizontal meridian and temporally to the median vertical meridian, and finally vanished completely. The left field began to show two indentations, one above and temporally, and one below and nasally, which became gradually deeper, but never met to separate the field in two islands.

The spinal fluid changes were as follows:

	CELLS	GLOBULIN	WASSERMANN	LANGE
December, 1916	50	+	4+0.4 c.c.	Paretic.
January, 1917	18	+	4+0.2 c.c.	. .
March, 1917	50	+	4+0.4 c.c.	Paretic curve.

The blood-serum Wassermann remained 4+ throughout.

Remarks.—This patient became progressively worse, both during the old routine treatment with potassium iodid and strychnin and the newer method with spinal and cranial injections. The latter was used only once, because the patient had a catarrhal jaundice which lasted a few months.

CASE VI.—Bess B., aged thirty-three years. Housework. Tabes. Bilateral optic atrophy (meningitic). Came under my observation at the Herman Knapp Memorial Eye Hospital on December 18, 1916, complaining that her vision began to fail in the right eye six months before, and that lately the vision of the left eye was rapidly declining. A course of seven intravenous injections of salvarsan was given at another institution previous to calling at our clinic. Luetic infection soon after marriage, several years ago. Examination reveals absence of patellar and ankle reflexes; diminished wrist-jerk; slight hypalgesia of both lower extremities. V.R.E., 20/200; L.E., 20/50, not improved by glasses. Pupils, irregular, unequal, slightly dilated, sluggish to light and accommodation. Fundus: Both optic nerves grayish-white, atrophic (optic atrophy from descending neuritis).

After a course of six spinal injections, six injections of mercury in the muscles, and six intravenous injections of salvarsan, we find her, on May 10, 1917, with a visual acuity in the right eye of 20/200, and in the left, 20/40++.

The acuity of vision remained stationary up to December, 1918. When seen last, she could read Jaeger 1 with the left

eye (adding +1 sph. to her distance glasses), while she could not read ordinary print before the treatment started. The blood-serum Wassermann was reduced from 4+ to 2+, and the spinal fluid findings were as follows:

	CELLS	GLOBULIN	WASSERMANN	LANGE
December, 1916	250	2+	4+ 0.10 c.c.	Paretic curve.
January, 1917	40	2+	4+ 0.2 c.c.	Paretic.
January, 1918	25	3+	4+ 0.2 c.c.	Paretic.

The fields of vision followed the usual course. The right field, concentrically contracted, showed also a marked indentation below and nasally, which, however, disappeared almost entirely after a few spinal injections. The left field of vision, slightly contracted (about 10 to 15 degrees), remained stationary during the entire period of about two and one-half years while she was under my observation.

Remarks.—This patient, with tabes and meningitic descending optic atrophy, has responded to the spinal treatment from the beginning. The exudations have been absorbed, the failing vision was arrested, and presumably some nerve-fibers resumed their function, as evidenced by improvement of the acuity of vision.

CASE VII.—Harry L., aged forty years. Electrician. Tabes; gummatous infiltration in the region of the optic chiasm; descending bilateral optic atrophy. Came under my observation at the Herman Knapp Memorial Eye Hospital in September, 1916, complaining of rapid failure of vision. Denies lues. Had been exposed to a strong electric flash seven years previously, and says that his sight remained weaker ever since, that the left eye is blind since two years of age, and the right eye has been failing rapidly for the past five months. The neurologic examination revealed slight incoördination of the right arm, diminished reflexes of the wrist, biceps, triceps, absence of right lower abdominal reflex, knee-jerk, and Achilles jerk. *X*-ray of the skull negative.

Ophthalmologic examination: V.R.E., 20/50; L.E., hand movements. Glasses do not improve. Pupils moderately dilated, unequal, irregular—right, sluggish to light and convergence; left, rigid to both. Fundus, right eye, apparently

simple optic atrophy; sclerotic changes of some of the retinal arteries. Left, optic disc slightly raised and blurred above; sclerotic changes of the retinal arteries near the disc. Field of vision: Classic bitemporal hemianopsia.

Patient was admitted to the hospital and given a course of six small doses of salvarsan intravenously between September 20 and October 23, 1916. Also potassium iodid in increasing doses up to 60 grains thrice daily. During this time his vision failed, and we find him in November, 1916, with 20/200 for the right eye, hand movements for the left. From November, 1916, he was given, in addition to the salvarsan and mercury injections, spinal injections of salvarsanized serum. He received twelve salvarsan intravenously, ten mercury intramuscularly, and seven spinal injections. The vision ceased to fail after the first spinal treatment. Repeated examinations during 1917 and 1918 showed no signs of deterioration, and the vision remained R.E., 20/100; L.E., fingers at two to three feet (nasally).

SPINAL FLUID FINDINGS.

	CELLS	GLOBULIN	WASSERMANN	LANGE
November, 1916	0	±doubtful	4+1 c.c.	Luetic curve.
December, 1916	4	±	4+1 c.c.	Luetic.
January, 1917	3	±	4+1 c.c.	Luetic (weakly).

The blood serum Wassermann was 4+ in September, 1916. The right field of vision showed complete temporal hemianopsia, but was normal in extent, in the seeing portion, for all colors. Only hand movements were recognized in a small field in the lower nasal quadrant, when patient first came under observation. Later on the field became larger but did not extend to the temporal side. The acuity of vision also increased to counting fingers at a few feet.

Remarks.—In this case, more than in any other, I have the feeling that the spinal treatment had something to do with the arrest of failing vision. To me it was a striking illustration of how important it is not to go half-heartedly about such cases. After having witnessed a reduction of vision from 20/50 to 20/200+ during a few weeks, while the patient was undergoing the salvarsan course, it required

quite an effort to decide to continue the salvarsan and add mercury and spinal injections to the treatment. I feel almost certain that this addition arrested the process. This consisted of an exudate in, or gummatous infiltration of, the chiasm, causing partly a blocking of its function and partly a degeneration of the fibers. The methods of reaching the chiasm by way of the blood-stream alone were insufficient, but the spinal treatment must have caused a meningeal reaction extending up as far as the chiasm.

CASE VIII.—Anthony B., aged sixty years. Colored. Hotel doorman. Cerebrospinal lues; bilateral optic atrophy (descending neuritis). Referred by a physician to the Herman Knapp Memorial Eye Hospital in January, 1917. Left eye blind for past three years; right eye failing for a few months. Chancre without skin eruption thirty years ago. Neurologic and general examinations negative. Ophthalmologic examination: V.R.E., 20/40 with correction; L.E., blind. Pupils slightly irregular, equal; right reacts to light and accommodation; left, rigid to light, reacts to accommodation. Fundus; optic atrophy (descending neuritis). After having five mercury injections and potassium iodid for a few months without success in arresting the failing vision in the right eye, he was referred to our clinic. Here he received a course of three spinal treatments, six intravenous injections of salvarsan, and six mercury injections between January and May, 1917.

His vision remained stationary during 1917 and 1918. In February, 1919, when examined again, he had 20/50 with his glasses, but could read Jaeger 1 with an addition of a corresponding plus sphere. He had not received any treatment for more than one year, and apparently some process of exudation must have taken place lately which resulted in slight reduction in the acuity of vision.

The blood Wassermann was 4+ when he was first seen and the spinal fluid changes were as follows:

	CELLS	GLOBULIN	WASSERMANN	LANGE
January, 1917	50	3+	4+	..
February, 1917	..	..	4+0.2	Paretic.
March, 1917	..	..	4+0.6	..

The fields of vision, slightly contracted for white, more contracted for red, showing an indentation of about 20 degrees above and temporally, remained the same in extent during the last two years.

Remarks.—This patient with both optic discs gray-white, completely blind in one eye, with beginning failure of vision in the other, responded to the combined treatment, spinal and general, and kept his vision intact for two years. Whether optic atrophies behave like this even when not treated or when treated by the old methods is hard to say. My experience is too limited to affirm or deny this, and reports from the literature are lacking in details of this kind. The process must have been a meningeal exudate, since the spinal fluid contained a large number of cells and the treatment succeeded in causing resorption of the exudate. Its location must have been in the posterior portion of the optic nerve, sparing the macular bundle, which here is centrally located, very near the chiasm, as suggested by the beginning temporal hemianopsia, marked indentation of the field above and temporally.

CASE IX.—Harry Cash, aged twenty-four; railroad engine fireman. Diagnosis: Lues (secondary stage), with bilateral papilloedema. Called at the Herman Knapp Eye Memorial Hospital in September, 1914, complaining of blurred vision of the right eye. History of luetic infection in January, 1914. On examination by the late Dr. O. Schirmer, the vision was found to be normal in each eye, 20 15−.

In December, 1916, he came back complaining of pains in the head and failing vision for one week. He had received 85 mercury and 18 salvarsan injections since June, 1914. V.R.E., 20 30+; L.E., 20 20. Fundus examination by Dr. Schirmer, Dr. Knapp, and myself: marked papilloedema on both sides, considered by the first two distinguished examiners as a characteristic neuro-recidive. A course of spinal treatments in addition to a more cautious general treatment was outlined and carried through. The vision varied during the following months in the right eye between 20 30+ and 20 70; in the left eye between 20 30+ and 20 50. The optic discs remained sometimes more, sometimes less, bulging and edematous.

By March, 1917, we find him with vision greatly impaired (R.E., 20/70; L.E., 20/50). He had received during the four preceding months 9 spinal, 8 mercury, and 15 salvarsan injections. Admitted to the hospital for rest, sweats, diet, and potassium iodid. Condition same after four weeks. During the following six months vision gradually returned to 20/30++ in the right eye and 20/15 in the left. During these six months he received 9 mercury and 9 salvarsan injections and potassium iodid by mouth. In April, 1918, we find him with a vision of 20/20+ for the right eye; 20/20++ for the left. The fundus examination shows the right optic disc congested, the retina adjoining it above, nasally, and below edematous for a distance of about one-half disc diameter; left eye, distinct edema of the retina adjoining the nasal portion of the disc, stretching over an area of about one-fourth disc diameter; also a large floating opacity in the vitreous.

In September, 1918, the vision in the right eye was again 20/100; in the left eye, 20/20. The right eye, according to the patient's statement, failed suddenly one week before calling.

Mercury inunctions for one month, and the right eye recovered vision to 20/30−; left, 20/20. March, 1919, V.R.E., 20/50; L.E., 20/20.

BLOOD AND SPINAL FLUID FINDINGS.

	CELLS	GLOBULIN	WASSERMANN	LANGE	SERUM
December 7, 1916	210	2+	4+0.1 c.c.	Luetic	4+
December 21, 1916	30	1+	4+0.2	Luetic	..
January 8, 1917	10	2+	..	..	..
January 17, 1917	41	2+	4+0.2	Luetic	..
February 7, 1917	8	2+	..	..	..
February 14, 1917	1	=	4+0.4	..	2+
February 23, 1917	..	..	4+0.4	..	..
March 14, 1917	15	=	4+0.2	..	..
August, 1917	..	..	..	..	4+
November, 1917	..	..	..	..	1+
September, 1918	..	..	4+0.4	..	1+
January, 1919	..	..	..	..	2+

Repeated careful neurologic examinations, negative.

The fields of vision, taken almost every month during the

three years of observation, showed marked variations as to their peripheral, central and paracentral portions. At times the fields were moderately, concentrically contracted, at other times they showed several paracentral scotomas.

The blind spots were constantly enlarged—the right much more than the left one.

Remarks.—The remarkable points about this case are: 1. The numerous recurrences. 2. The methods of treatment (potassium iodid, spinal, intravenous, and muscular injections) carefully administered, with long periods of rest between. 3. The absence of permanent damage to the optic fibers, in spite of the length of the process and repeated recurrences.

What is the condition we are dealing with in this patient? Is it a papule-like process in the optic discs? Is it a gummatous process? Is it a nest of spirochætæ?

Papules, judging from the way they behave in the iris or other parts of the body, respond very readily to salvarsan and do not recur if treatment is kept up. The repeated recurrences of edema of the head of the optic nerves, the little damage done to the fibers, the persistency with which the Wassermann plus reaction recurred in the spinal fluid, are very suggestive for the presence of a focus of spirochætæ in the optic discs. But, of course, this is only a presumption.

SUMMARY.

1. "Earliest" diagnosis versus late diagnosis of syphilitic involvement of the optic pathways is possible only by the routine, periodic ophthalmologic examination of every luetic from the beginning of infection throughout his entire life. The earlier this is brought home to the general practitioner and syphilographer the sooner ophthalmologists have made a very valuable contribution to the practice of medicine.

2. The manner in which the subject of syphilitic optic neuritis and optic atrophies is treated in the classic textbooks is a handicap to its proper understanding. This chapter will have to be rewritten by ophthalmologists interested in the neurologic and syphilographic aspect of the subject.

The importance of this point of view is made patent by the consideration of the possibilities of making a more precise diagnosis and prognosis and mapping out clearer indications for treatment. Furthermore, it brings us nearer to the nucleus of the therapeutic problems concerning syphilis of the central nervous system and of the cranial nerves as a whole.

3. The few cases reported in this paper are selected to illustrate various types of luetic involvement of the optic pathways and their response or lack of response to the old and new methods of treatment.

These cases suggest several fundamental questions:

Why did they fall into the hands of the ophthalmologist years after the condition had started?

Why did many of them fail even after the ophthalmologist had them under control?

What is wrong with our present system of handling this class of patients?

Can part of it be remedied at the present time?

What is wrong with our methods of treatment, and what with our therapeutic agents?

Does the entire subject of syphilis of the central nervous system stand a chance of being rapidly advanced if the old, inefficient methods of study are continued?

Is it not time that special institutions should be established for the treatment and study of syphilis by complete teams of physicians and pathologists?

Is it within the sphere of ophthalmologists to take active part or the lead in such a movement?

MILITARY OPHTHALMOLOGY.*

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Prefatory Discourse.

What interesting reading it would be, to ophthalmologists, at least, were some industrious searcher to pore over the Surgeon General's Records, say five years hence, when they should be more accessible and complete than now, and glean therefrom statistical percentages showing the exact types of eye wounds characterizing the casualties of each separate engagement.

Thus would be paralleled the type of the warfare, as to time of day or night, season, topography of the site, whether offensive or defensive, open or trench, main weapons employed, etc., with the preponderant varieties of injuries received. For example: Though noted but grossly and qualitatively in the pressure of the times, the sudden change from the routine of grenade injuries and "gassed" eyes around the time of the Seicheprey and contemporaneous trench fighting, to the flood of machine-gun and high-explosive-shell wounds occurring from about the time of the Château-Thierry "show" to the Argonne and Meuse heights "push," when the warfare was so relatively "open," impressed the writer and his colleagues forcibly. However, this phase of the matter cannot, at the present time, be taken up in the body of the ensuing article, which is intended to handle the subject, "war ophthalmology," in the most general and informal way possible.

* Candidate's thesis for membership accepted by the Committee on Theses.

The following pages were written during hectic moments snatched from the routine of busy army life, at an evacuation and advanced base hospital, where, obviously, save for the occasional ophthalmic journals which were not lost in the mail and a few standard text-books, there was, practically speaking, no reference library at all. Perhaps it was just as well that such was the case, because no scientific aspirations whatever have been entertained in the compiling of these notes. The mere desire to chronicle, in a practical way, the broad general nature of eye work as met with behind the lines of combat in our modern warfare having stimulated the writer.

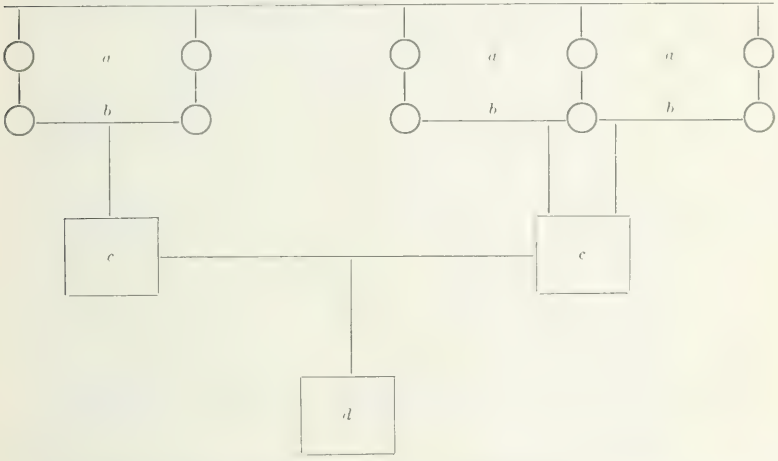
There have been, it is needless to say, a legion of difficulties in the collecting of accurate data: patients have often had so many other wounds that proper ocular studies have been impracticable; others have been evacuated before adequate tests could be conducted. Again, laboratory materials have become exhausted and supplies failed to arrive, hence desired reports were not had on needed cases; also consultants have often been ordered away or been too busy with other affairs, rendering impossible complete investigations of some of the most interesting ophthalmic cases. Moreover, when ideal types for physiognomonic or graphic recording have been in the wards, the medical artist has been ordered elsewhere, or to do other work, and his services lost. Similarly, the photographer has been sent hither and yon, on minor chores, and his special assistance foregone when most required. In addition, numerous photographs, showing various interesting features of the eye center, and depicting its correlated life in the surrounding hospitals-general, have been accidentally and unavoidably mislaid, damaged, or destroyed.

But sufficient to reiterate that insurmountable difficulties have prevented the writing of a thesis which could, according to the standards governing the exact and scientific produc-

tions emanating from the smugly tranquil departments of a model civil hospital at home, be regarded as of exact or technical worth. Thus the writer will feel amply rewarded if something of genuine, relative interest be found by those perusing these pages.

I. Outline Methods of Our Allies in Handling those Wounded in Regions Directly or Indirectly Ophthalmologic.

1. *French Front*



a, Post de Secour. No ophthalmic differentiation.

b, Ambulance de l'avant. No ophthalmic treatment save aseptic bandaging.

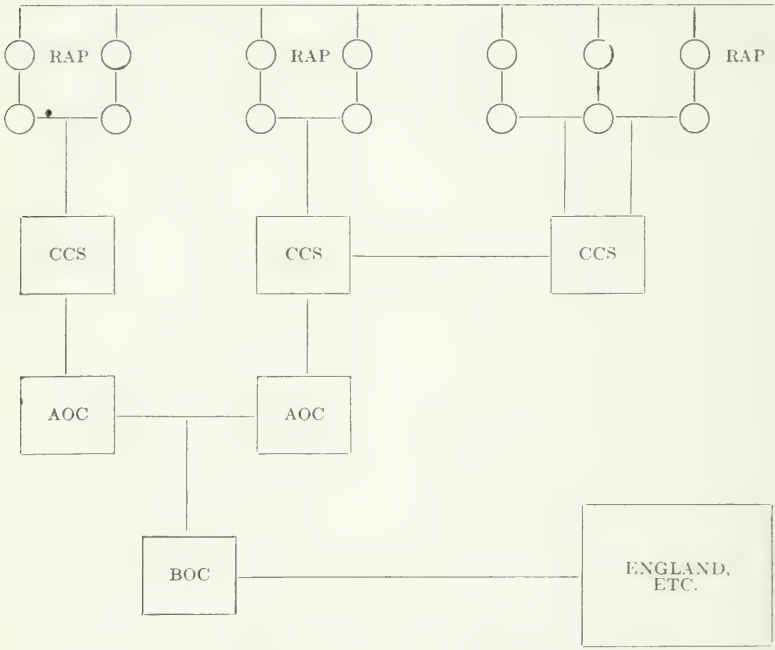
c, Centre Ophtalmologique. These are organized independent of the number of divisions, and where the need is peculiar, and are situated in some convenient place about 50 kilometers from the lines In this hospital a man with some ophthalmic knowledge is stationed, and patients with minor injuries or ailments are kept until fit for service at the front. Here are performed simple eye operations which are sure of success and patients' speedy return to duty, or imperative operations when it is certain that patient will soon be able to leave for the rear and thus release his bed.

d, Paris (Hôtel Dieu, Val de Grace, No. 521 Hospital Militaire, Quinze Vingt, Lariboisiere, etc.), Tours, Orleans, Nantes, Lyons, Bordeaux, etc.

When it is realized that a patient's military status will be changed and that he will be dismissed from the army or put on auxiliary service, or when the operations or examinations

will require a long time and exceptional ophthalmologic training, the soldier is sent back to one of these cities and there studied and kept under surveillance as long as necessary. Here are large eye dispensaries for ambulatory eye

2. *British Front*



RAP, Regimental Aid Post. No ophthalmic differentiation.

FA, Field Ambulance. No ophthalmic differentiation.

CCS, Casualty Clearing Station. Eye cases given "ophthalmic ticket" and sent directly to Base Ophthalmic Center. If impossible to do so, a consultant is called from the Advanced or Base Ophthalmic Center.

AOC, Advanced Ophthalmic Center. Minor ocular conditions which can be readily cured and insuring soldier's immediate return to the front, or cases complicated by other severe bodily injury, preventing shipment to Base Ophthalmic Center, which must be operated upon here. Doubtful cases sent to Base Ophthalmic Center for consultant.

BOC, Base Ophthalmic Center. All eye injuries, except those enumerated, are sent directly from the CCS. Here all important magnet extractions, all important operations, detection of simulated amblyopia, shell-shock cases, refractions, diseases, etc., are cared for, whether patient is ultimately to return to the front or be dismissed from service, and here the large mobile magnet, which supplies its own current, is stationed, to be rushed to other hospitals or ophthalmic centers in consultation.

patients, officers, and soldiers, who must be treated over a long, long period of time.

Also, connected with the Hôtel Dieu is a large department for the reëducation of the blind soldier. Instruction (typewriting and stenography, wood-carving, brush and broom manufacture) is begun while the patient is still in the hospital convalescing, so that no time is lost and the patient is kept actively employed and started on a useful occupation before he fully realizes his condition, thus preventing the tragic brooding over his misfortune.

N.B.—This is of the utmost importance when we consider that there were in August, 1917, when the writer was visiting these places, 2400 totally blind in the French army and some 700 in the British, not counting the thousands who were blind in one eye, practically blind in both, as far as useful function was concerned, or who would probably become blind from the inevitable progression of their troubles.

The Dublin No. 83 General, at Boulogne, is the best example of a BOC in the English army. In this institution an eye dispensary is run which yields a daily average of 100 patients, 20 per cent. of whom are refraction cases, the men coming from neighboring convalescent camps, from details waiting to join regiments, from those at permanent base, and from the ambulatory patients of the hospital. Prior to admission here, and when the wounded are taken off the trains, they are divided up: if the predominant wound is the ophthalmologic, they are admitted to the eye ward, which has 150 beds, whereas if the general wounds are the most important, they are sent to other wards, where the oculist visits them in consultation. Here, as elsewhere, many trained ophthalmic surgeons are greatly needed and actively employed all of the time.

Work at Ophthalmic Center.—(*a*) The advanced location of the center implies that its beds are sorely needed for the treatment of those whose injuries are a matter of life or death. Therefore, injuries of the eye, and other relatively minor organs, which require special treatment, are handled at a point less apt to become congested with the acutely wounded. However, when no offensive is on or contemplated; when the beds are well emptied; when the eye injury is merely a complication of some graver injury necessitating the reten-

tion of the patient at this point; when the ocular malady is of a minor nature, and it is assured that treatment or operation will have the immediate effect of restoring the patient to his command—then the cases are satisfactorily handled here.

(*b*) It is out of the question to have a very complete ophthalmic equipment economically carried at such a post, the amount and character of eye work done here not warranting it; any ocular endeavors must be undertaken entirely subordinate to other surgical conditions existing at the time. Here many radical procedures are apt to be premature.

Work at Ophthalmic Base.—(*a*) Here patients are detained as long as necessary for the most thorough and skilled examinations and treatment; the equipment is most complete. Here all magnet extractions possible are done (scientific manipulation reducing the trauma of the operation); all radical surgical procedures performed; all tedious investigations (perimetry, scotometry, tonometry, phorometry, etc.) conducted; in fact, all problems (the man's fitness to return to the front, to perform auxiliary military service, to be dismissed) requiring mature judgment and deliberation are decided, for one cannot tell much about the nature of an orbital, ocular, or optic tract lesion immediately after injury, because of local swelling, hemorrhage, general shock, insidious onset, subsequent contraction of cicatricial tissue, etc. Even the dreaded sympathetic ophthalmia, as its particular investigator, Fuchs, of Vienna, has pointed out, does not occur, as a rule, short of four to eight weeks after injury, and judicious handling of the case may save both eyes. The writer was greatly impressed by the number of cases of lesions of the cornea, iris, and lens with practical vision ultimately secured after special treatment or operation; extraction of the oft-occurring traumatic cataracts, optical iridectomies and iridotomies for adherent leukomata, cyclitic membrane, etc., as well as by the excellent results after the hideous ectropions and other orbital and palpebral changes incident to burns and trauma of this and adjacent regions.

(*b*) Here the exceedingly accurate examinations, necessary in the detection of malingering, are undertaken. The number of these simulators in both armies is astounding,

there being those who, desirous of dismissal, feign semi-amblyopia in both eyes, with or without shell-shock; those who introduce irritating substances into the conjunctival sac to produce chronic conjunctivitis; those who, seeking discharge with compensation, endeavor to palm off old ocular lesions, undetected by the recruiting officer, as recent affections incurred in the line of duty, and numerous other types of pretenders most difficult to foil.

(*c*) Here the plastic or, at least, preliminary plastic, operations are performed in order to render the pathetically grotesque and repulsive looking gross wounds of orbits, eyes, and adnexa less unsightly and more presentable to their relatives and friends upon their return to home hospitals for finishing touches.

(*d*) Also here has been adopted the time, money, and labor-saving practice of having an optician and small optical establishment with a goodly stock of ready-ground, standard size, convex and concave spheres and cylinders, with their combinations, and a strong, durable, sensible, standardized spectacle-frame, issued gratis to the patient. This prevents loss of time in returning soldiers to service, eliminates what the English call "tourists," those who complain of eye-strain to get a trip to Paris or London, for example, and furnishes on short notice a duplicate lens for a broken one without losing the soldier's services. No grinding is necessary, as the lenses are round and can be rotated to the proper axis before tightening the frame.

The problem in the American army is more like that of the French in some respects, for the English can, and do, send their late and most difficult cases back to England for the final work, whereas our hospitals in France are obliged to do much of that sort of surgery, inasmuch as the transportation is a problem, and some of the injured men can be reclassified and used for auxiliary military service or even returned "Class A" and sent back to the front within a few months.

Patients in base hospitals with ocular injuries or diseases are not always kept until well. If the case is very simple

and no serious damage to function has occurred, he is usually retained until recovery and then "discharged to duty," implying that he is a "Class A" man. If, though he may make a speedy surgical recovery, he has been so injured that one eye is lost, or practically so, but the other retains vision sufficient for auxiliary service (quartermaster or medical corps, clerical work, etc.), he is brought before the hospital's reclassifying board, and if well enough to go to duty at once, as after a successful enucleation, he is "discharged to duty, Class C"; if not well enough to resume activities, and if his bed is sorely needed for incoming cases, he is evacuated to a base further back, preferably the large hospital at Vichy, where most of the tedious plastic surgery is done, with advice that he be reclassified there as a "C" patient. In the event that he has a chronic malady which will ultimately be cured, and which will not prevent him from finally returning to duty as an "A" patient, but will keep him in the hospital for an indefinite period of time, he is evacuated as class "B." "Class D" comprises those unfortunates, either blind, or practically so, in both eyes or with grave ocular disorders which render them entirely incapable of useful service, immediate or ultimate.

The following is an abstract of the official order regarding the standards which govern United States army oculists in the cases of eye defects:

"Class A: To include men with uncorrected vision of 20 40 for the better eye and 20 100 for the poorer eye, provided no organic disease exists in either eye.

"Class B: To include cases of toxic amblyopia, active choroiditis, interstitial keratitis, ocular paralysis with diplopia, anterior or posterior synechia, if awaiting operation, and trachoma.

"Class C: To include men with uncorrected vision of less than 20 40 and 20 100 and men with a corrected vision of 20 70 in one eye, the other being amblyopic or blind.

"Class D: To include men with corrected vision of 15 200

or less in each eye; men blind in one eye with corrected vision in other eye of 20/70 or less; men with glaucoma, retinitis pigmentosa, optic nerve atrophy, high myopia with extensive fundus changes, and disseminated choroiditis."

While troops are reclassified as to vision according to this general order, a certain amount of latitude is allowed the ophthalmic surgeon in interpreting this, to the end that men with useful vision, but not strictly within the above standards, shall not be lost to the service.

II. A certain amount of early operative eye work rewards the oculists stationed at advanced institutions, such as field, evacuation, or mobile hospitals, but the equipment is never adequate to the needs of first-class ophthalmic surgery, and the writer has often seen the results of too hasty operative interference or medical diagnosis, usually, as in the case of an improperly localized foreign body or incomplete laboratory tests, due in no way to lack of ability on the part of the ophthalmologist. In times of "drives" all special work becomes subservient to general surgery, and the "eye man" usually finds himself administering anesthetics or assisting in a débridement, while most of the important eye cases are passed through untouched and tagged for the nearest eye hospital.

There are certain advantages accruing to those physicians employed in the ocular service of the average base hospitals situated remote from the front. There is less necessitated moving of patients, and cases may usually be kept as long as desired or as seems expedient for the proper studying and recording of any extraordinary features, making thorough research thereby possible. It is from these hospitals that the best medico-ophthalmic and neuro-ophthalmic reports have emanated, while the more perfected oculofacial plastic surgery has been developed in these quieter, more permanent stations.

But little "fresh" work, however, comes to their hands, and cases have usually been operated upon four or five times before they reach these gentlemen, so that they are seldom able to enjoy those wonderfully rapid and satisfactory results, but must eke out their cures in patience over periods ranging from months to years.

Thus, to taste of the extremes, and to glean a rich personal experience in ophthalmology, a base hospital in the advanced zone would seem, to one who is conversant with the daily routine of the others, the most profitable establishment in which to "put in a service," for here, of all places, the oculist finds the broadest general scope for the exploitation of both the medical and surgical aspects of his specialty.

To begin with, such an hospital is surrounded by divisions in training, or *en répos*, and receives just the type of cases for which a camp hospital is organized, with the difference that it may retain and care for, to the time of recovery and return to duty, many cases which the camp hospital must immediately evacuate to the base because of lack of equipment.

One ordinarily receives from this source cases which have been injured but an hour or two, so that the prognoses are usually excellent. Some of the most interesting eye wounds the writer remembers having seen were those caused by reckless dropping of grenades during instruction, accidental discharge of rifles, premature explosion of rifle grenades, back-firing of faultily constructed shells, careless cleaning of weapons in billets, etc. The writer particularly recalls this incident illustrating the type of work: One day a company was lined up preparatory to being dismissed. One man with a sack of thirty grenades over his shoulder, much irritated because of the heavy load and the hard work, angrily tossed the grenades to the ground. Evidently some pins became loosened, and the upshot was that the whole line was mowed down and a number killed outright. It seems to the writer that there were about six, perhaps more, eye cases in that

mêlée. Another oft-occurring accident is the result of making "war souvenirs." Soldiers sitting about the stove at night unloading shells or cartridges will either throw powder or a part of the shell into the stove, or will, in attempting to unload the time fuse of the shrapnel, cause it to explode. At the time of writing the author has under his care seven men with wounded eyes, most of them bilateral injuries, all caused by the same explosion, being onlookers at the unloading of the detonator of a small explosive one-pounder.

The problem of ocular hygiene among troops quartered in crowded wooden barracks, where, in order to keep warm, the ventilation must be far from ideal, is another interesting point, and the writer has not infrequently been called in to determine the source of a "pink eye" epidemic. Our soldiers, moreover, are great readers when off duty, and with the miserable illumination afforded by candles or lanterns, much asthenopia, subjective and objective, is encountered, men being daily shipped to the dispensary in truckloads from various camps because of conjunctival congestion, follicular hypertrophy, blepharitis marginalis, etc.

Small amounts of refraction error are not, as a rule, corrected; a few words relative to personal ocular hygiene and the institution of some needed therapeutic measure usually sufficing to effect a cure. But there are always many headquarters companies or quartermaster staffs, etc., where much clerical and other indoor labor, requiring close ocular application, is carried on. These patients often work more unremittingly, for longer hours and under wretched illumination, than they did in their ideally lighted, well-ventilated offices at home. Thus painstaking trials of muscle power and balance, as well as estimation of slight refraction errors, must be minutely conducted, and carefully conceived remediable measures instituted, so much depending upon the efficiency of these individuals.

Then there are innumerable so-called "labor battalions"

quartered about the countryside, working quarries, repairing roads, laying water-mains, constructing barracks, and what not. These persons, who, with the exception of our drafted negro workers, are usually men of a rather low-grade physical standard (Chinese, Portuguese, Spaniards, and French, whose age or physical defects render them unfit for military service), are even more crowded and poorly quartered than the soldiers. There is usually a sort of an all-round medical officer, but with scant knowledge of eye diseases, attached to each large camp, and it is necessary that the base hospital oculist visit such places from time to time and examine each man for trachoma or other contagious eye affections, segregating the affected ones, as well as their personal effects, towels, etc., operating when needful, and instructing the medical officer in the subsequent treatment. Lieutenant Colonel Derby, who had much experience with the inspections of the British "coolies," has had charge of this branch of the work, calling upon the base hospital ophthalmic surgeons to aid him in the visits to the camps in their respective districts. He contemplates, it is believed, reporting his experiences later, so that little space will be given it here other than to outline roughly the methods employed.

The commanding officer of the "labor battalion," members of which may be scattered at work over several square kilometers, is communicated with by telephone and requested to have all his men corralled at a certain time and lined up in as many queues as necessary, depending upon the number of inspecting physicians. The latter motor to the rendezvous at the appointed hour, stand at the head of the lines, and proceed with the inspection, very much as is done at the Ellis Island Immigration Station, dipping the hands in lysol between each case, and washing them, after a detected infective one, calling out to a clerk as he passes them on whether the patient is to be put in contagious trachoma, non-

contagious trachoma, acute conjunctivitis, and chronic conjunctivitis classes, or is to be sent to the base hospital eye clinic for minor operations or treatments because of existing chalazia, hordeola, dacryocystitis, etc. When the camp physician treats the patients, according to the orders left by the oculist, which are simplified and standardized as much as is compatible with satisfactory results, both as to drugs and time of administration, in order to interfere with patients' labors as little as possible, he orders the men to be lined up according to their ocular classification. They then squat down, with heads thrown back, while the sergeant passes along the lines with the medicines, administering treatment to each. It is an extremely interesting and amusing tableau to see long lines of grinning, jabbering Chinamen squatting in delirious anticipation, or blepharospastic realization (oddly enough, they adore the treatments), for their turn to have their eyes attended to.

In a base hospital, particularly when one of a large group composing a hospital center, the oculist in charge gets a volume of consultation work, both general and under the head of ophthalmology; fundus examinations, visual field tests, muscle and refraction testing, in connection with medical and neurologic studies particularly, as well as advice regarding indication or non-indication for operative procedures, advice as to the type of operation, magnet extractions, reclassifications, etc.

Moreover, there is of necessity much unavoidable work among the poorer civilians. So many of the French oculists were mobilized early in the war, many of the younger ones, owing to the shortage of medical officers, doing routine poste de secour work, ambulance roentgenology, or even general surgery, throughout the past four years, that all of the smaller cities are practically stripped of eye men. Thus, unless they can afford to visit Paris, Lyons, Bordeaux, or one of the larger centers, the peasants must allow their ocular maladies to go

untreated, the writer having witnessed one or two most tragic cases of neglect, one gonorrheal ophthalmia going on to complete perforation and loss of vision before the patient was ever seen by a physician. Therefore, emergency work among the civilians of the neighboring towns is a gratifying part of the base hospital oculist's duties, both from the viewpoint of well-placed charity and from the constant refreshing of his erstwhile knowledge of civil ophthalmology.

The American Red Cross established, shortly after the writer's arrival in France, their excellent hospital for the treatment of the French civil population living in the zone occupied by the American army. This was situated four miles away, and, as there was no oculist on the staff, the author, by invitation, gladly played the rôle of volunteer consultant throughout the existence of said institution, which was closed after the enactment of the armistice. In this way he was able to operate upon the surgical cases and have medical ones entered for their very necessary ward care, who would otherwise have had to be treated as outpatients, admission of such cases to an army hospital being strictly interdicted.

Lastly, and most important, ocular, medical and surgical maladies of battle origin were received here from one to five days after injury in the trenches, coming, ordinarily, from the intermediate field hospitals, but during "drives" direct from the ambulance itself, a semi-daily hospital train service bringing them to us by the thousands, and thus insuring, day and night, a surfeit of freshly wounded, preoperative eyes.

During customary combat conditions we were able to study the cases with reasonable thoroughness and to observe their progress with satisfaction, but during the rushed times the only gratification was the variety and the volume of the surgery, it being impossible, for example, to secure Sweet localizations of foreign bodies or to hold the cases long after

operation in order to conduct other tests or observe the results of one's operative endeavors.

III. The importance of well-trained oculists and complete ophthalmic equipment as near the front as geographically and tactically possible cannot be overestimated, and should, by this time, be well recognized by observant military surgeons.

To begin with, having the oftquoted example to the contrary, Napoleon's home-coming army, with its spread of "Egyptian ophthalmia" throughout Europe, ever before us, one is more than justified in this stand, solely in the preservation of the ocular hygiene in barrack and camp, dugout and "prison-pen," and the prevention thereby of the spread of eye diseases from soldier to soldier and from labor battalions or civilians to soldier, thus insuring a high upkeep of effectives and obviating much unnecessary drain upon replacements.

Again, by precluding the delays in simple diagnoses and the needlessly prolonged recoveries of diseased or injured eyes in men whose services are vitally required at the front, expert ophthalmic treatment usually guarantees not only the speedy return of such cases to duty, but saves incalculable sums to the tax-payers in the otherwise unjustified expense incurred by the inactive man's prolonged hospitalization, personal upkeep, and further time and travel lost in shipment to replacement camps and other centers. In the earlier days of our army's sojourn in France the writer has seen cases which were sent from pillar to post for simple refraction tests or some minor ailment, and for this or some similar trifling condition kept from performing duty with his organization for weeks.

Another class of patients which, in the absence of trained ophthalmic supervision, may remain from their posts for unnecessarily long periods of time, if not permanently, are malingerers. Fortunately, in "this man's army," to quote

the expressive vernacular of the "dough-boy," this type of creature is a rarity. But he exists, nevertheless, as the writer knows from perplexing and exasperating personal contact, and the longer he remains undetected and pampered in the deception the more perniciously educated in his game the simulator becomes, and the more progressively difficult it is to expose him. If these cases are tested by expert ophthalmologists early, the less will be the time lost to the country in their services. Moreover, it is psychologically true that if the average malingerer, who is, after all, often only a foolish, ill-advised young fellow with "stage fright," is detected immediately, shown how futile his policy is, firmly but kindly talked to, and given another opportunity, concluding with a stirring appeal to his manhood, he will return to his command, adapt himself with reopened eyes to his environment, and prove a rather worthy soldier. How often, in just such cases, is one doing good not only to the army, in the restoration of an otherwise lost effective, but to society in general in salvaging early this prospective human derelict!

Again, in an army where keen, up-to-date ophthalmology is practised, men with ocular affections (refraction errors, strabismus, etc.) which would otherwise handicap them in their work and produce second-rate achievement are given the best of treatment, rehabilitated, and rendered much more efficient. By elevating the standard of these scattered ocular defectives it is impossible to tell what a favorable influence is exercised upon the morale of the whole military organization.

When battle injuries and maladies receive from the start scientific, well-judged care, there are few mistakes which would otherwise determine the failure of the measures instituted, and patients who might, under a different arrangement, become actually blind, have their vision saved and placed again at the disposal of their country.

IV. It is obvious from much that has already been said that thorough work can be done only at a base, though the exigencies of the case often demand immediate operation, and one does, under the circumstances, the best possible for such patients in advanced stations.

To begin with, there is seldom sufficient time, even during moderate activity, for accurate roentgenologic localizations, such as those possible by the Sweet method, which the author prefers, and one usually has merely the report that there are one or more foreign bodies, as the case may be, in the region of the eyeball. Commendable as operative interference and the use of the magnet are in such cases, the writer knows of a number of instances where foreign bodies were pulled by the large magnet from positions in which they might have been removed by the posterior route by sclerotomy and the use of the small magnet, if only it had been feasible to wait for accurate localization.

At field and evacuation hospitals time is such a factor that but hasty studies can be made, save the exceptional "snap diagnoses." It is impossible for the oculist, no matter how clever he may be, to arrive at any definite and reliable conclusions regarding cases that are in the slightest degree obscure. Time, particularly in diagnosing vague ophthalmologic conditions, is an all-important factor, and, without the correlation of all the collateral medical, laboratory, and special consultation reports, as well as the numerous strictly ophthalmic investigations, one is often hopelessly at sea. Another reason why thorough work can be done only at a base is owing to the noise of shells, rocking of bombs, or to the constant "shuffling" of the patient from place to place or ward to tent, etc., to make room for other cases. Sufficient of the all-essential bed rest is not permitted, and those cases whose convalescence demands absolute freedom from handling or moving about simply do not recover as well as they would further back. There are two other factors that

make for more thorough work and better results in a base, one being the more complete and better equipment, as well as greater space and permanency of quarters, the other being the ability to set aside certain wards for strictly eye cases and certain nurses who can be taught to conduct, more efficiently than the average, the various routine ocular treatments and technic.

V. When eight, ten, or more base institutions are grouped together to form a hospital center, it has been the policy of the headquarters of the Medical and Surgical Consultants of the American Expeditionary Forces to form communal clinics in each specialty and to scatter them about the group; by way of illustration, the facioplastic clinic at one hospital, the neurologic at another, etc., having all the men of each specialty detached from his original unit, save for the handling of what minor routine eye cases may crop up, from time to time, among the personnel or the sick and wounded in his particular establishment, and to work in the common clinic, which has been founded for his specialty.

In many instances this plan has been eminently successful, but its efficacy has been considerably mooted. The writer does not feel sufficiently informed upon the subject to discuss it as it pertains to other branches of medicine or surgery, having heard both viewpoints excellently defended. While he believes an oculist should be quartered in each hospital for the routine consultation, he is certain that it is vastly better not to have each base hospital eye clinic equal and unassociated, but to merge them into one large group eye dispensary to which all the oculists should send their cases, as well as convene daily for examining, treating, or operating upon the same, under the supervision of one man whose capabilities or temperament may render him more suited than his fellows for shouldering the responsibility for the proper treatment of the cases.

The first argument for this, based upon many occur-

rences, unfortunate alike for both the patient and any conscientious observer, is that working alone and handling a variety of cases, some with novel complications, may throw too great a responsibility upon an inferiorly trained man or one whose previous ophthalmic experience has been along other lines. Besides this, a man who works alone, never having the opportunity to talk over knotty problems as they arise or to exchange views and examination notations upon actual patients with another oculist, grows ophthalmologically warped and narrowed, especially when living under such restriction, military and topographic, as are attendant upon life at a post in a bemired French village, and not having even the stimulation which he would derive from the periodic medical meetings he is wont to attend at home. Constant association and case discussion in the clinic room, with better informed colleagues, will often start an inferiorly trained specialist afresh and develop in him a better line of thought, so that a higher type of work will be evolved. The writer has witnessed the living enactment of this very contention on more than one occasion.

In this connection it may be remarked that the most thorough and expeditiously achieved results in conducting the daily clinics and ward rounds seemed to come from holding each man to a certain kind of work, in alternating services; that is, to have a man do refraction for a month, diagnose and treat the inflammatory cases for another month, and operate upon and dress ward cases for another month. Not only did this prove a time-saver in handling patients, but a smooth routine was established and confusion avoided, each man adapting himself to his duties and proceeding without delay to their enactment. Furthermore, it imparted an atmosphere of equality and fair play which brought out the best in the way of willingness and interested coöperation. It proved an excellent means of discovering the strong as well as the weak points of a man who might, for

example, be a very good surgeon but a poor refractionist, retinoscopist, or ophthalmoscopist, etc., and by tactful surveillance and daily comparisons of his results with those of the other ophthalmologists his pride and interest would be aroused to the point of producing more carefully worked-out results. In all, it seemed to make for a happy, agreeable, and reasonably efficient association of men whose ophthalmic upbringing and ideals were, at the start, as diverse as the geographic differences between their homes.

Another point against the separate clinics in each hospital is the great amount of unnecessary duplication of equipment and wastage of floor space which could be utilized for more beds or to some other greater advantage. One trial-case, by way of illustration, could be employed for two or more men in a large clinic because one of them might be slitting a canaliculus and another taking visual fields at the same time in which the third was using the lenses. The same is true of the operative and other instruments.

In France, particularly, the group system has proved more practicable because of the relative rarity of optical units. It is quite evident that, with so few skilled opticians in the service and with cut lenses at a premium, it would be, at the present, quite out of the question to have a group of these men, together with a complete stock of cut lenses and other optical paraphernalia, quartered at each base hospital, it even being impossible to have one for each hospital center. From this it will be seen that should refraction patients be examined and prescribed for at each base hospital, they would still be obliged to visit the clinic in which an optical unit was installed in order to have their prescription compounded. Obviously, this is a great waste of time and transportation.

In conclusion, to view it from the standpoint of the medical officer in charge of unloading the hospital trains: how impossible it would be to sort out so-and-so eye cases for this

hospital, and such-and-such a number for that, etc.: It would be far simpler to glance at the large green tag "EYE," which was pinned to the patient when he was first dressed "up the line," and to direct the assistants to send all such cases to one definite hospital.

VI. To any who have routinely operated upon eyes, both in a large, many-tabled, general surgical amphitheater, and in a smaller, specially provided, strictly ophthalmic operating room, it is hardly necessary to contend for the necessity of the latter or to endeavor to demonstrate why the work in more advanced hospitals than a base is less satisfactory because of the lack of this arrangement.

First, it is far easier to store ophthalmic apparatus, magnets, and other instruments where they will not be moved or pushed about, injured, or mislaid, and where they will be ready for immediate use. Second, special dressings, used only for this character of work, can be kept always at hand and not confused with the heterogeneous supplies which are always kept in abundance for the surgeon, orthopedist, laryngologist, et al. Third, a nurse, easily trained to the work, who understands how to care for the delicate instruments and fine apparatus and comprehends the peculiar and special wants of the operator, can be kept here with reasonable permanency, and one will thus not have the many little obstacles which continually harass the eye surgeon who works in a large general amphitheater. Fourth, there is no doubt of the greater danger of secondary infection, scrupulous as the technic may be, when operating upon eyes in a room continuously being used for the severest sort of pus and "gas bacillus" cases, and any one realizing how rapidly an eye is lost when infection once enters through an incision will agree with this. When one reflects that during rushes it is often necessary to operate immediately upon most of the wounded eyes as they come in, mingled with every variety of wounds and infections in a convoy, at which time the pre-

viously mentioned pus cases will actually occupy the neighboring tables, the consideration assumes a graver hue.

VII. A person naturally thinks of troops as composed of young, vigorous, carefully selected men, little dreaming that physical defects, and particularly errors of refraction, exist in a considerable proportion. Were those needing glasses the exception, rather than the rule, it would be quite possible to allow the patient sufficient time to visit the optician, as at home, in order that he might have his prescription made up. But when it was realized that so many should have lenses, that their prolonged absence from their posts would be an incalculable handicap to the efficiency of the army, the pressing need for optical centers as a part of the military organization was acknowledged, and such institutions were established the latter part of May, 1918, the British and Germans having led the way. (This was advocated by the writer in a long letter to the then assistant chief surgeon, Colonel Ireland, August 30, 1917, subsequently recommended by Colonel Wilmer; organized in the United States, February 25, 1918, and sent to France May 4, 1918.)

Certainly the cry for these units was sufficiently justified. Only in this way is it possible to insure quick repairs of broken mountings or lenses for officers and men coming from long distances, and whose duties are imperatively required at the front or with their commands. Only by such an arrangement is it possible to furnish patients immediately with their properly correcting glasses. In the pre-optical-unit days, at least six weeks or more often two months were required for the delivery of a mail order for spectacles from any private optical concern in France, owing to the shortage of labor, the dearth of supplies, and the slowness of the war-detained postal service. Moreover, this gratis issue of completed spectacles saves the men the invariable overcharge exacted by private concerns during war times. A distinct advantage is that patients convalescing in the hospital from

other maladies, who must amuse themselves by reading and who have usually lost their glasses, together with other personal effects, when wounded, are able to have their necessary lenses at once and thus conserve their eyes, already often weakened by long periods of fever or other enervating influences.

The system of pasting a gummed prescription label, with the patient's exact correction, in his pay book insures his record going with him wherever he may be, so that, should he lose or break his glasses, telephoning or writing the prescription to the nearest optical center will bring a new pair by return post. The absolute standardization of lenses and frames has proved most satisfactory, and obviates confusion and useless expense to the government, while with a ready-made stock of lenses in sequence it becomes possible to substitute the next nearest strength in the event that the exact number specified is out of stock at the moment. Because of this the patient will promptly have a correction which will materially aid him in the continued performance of his duties during the time he is awaiting his proper pair.

The system was, of course, young when the war ended, and distinctly capable of numerous minor improvements. One of the drawbacks was practically unavoidable, *i. e.*, the continued dwindling of the lens stock and the slow and insufficient replacement of used lenses. This was due to the fact that only ready-edged 40 mm. lenses were shipped from America, and, to a lesser degree, from the optical branch of the medical repair shop in Paris, and the chief optician in the writer's clinic has often pleaded for an edging stone, saying that he could turn out much more work with a stock of more speedily delivered, unedged lenses; as well as save supplying frames and many superfluous lenses by utilizing many of the excellent but different sized mountings and glasses brought in for repair, if this accessory were available. If any optical units should be organized in the future, more

complete equipment, along the lines indicated, will prove an investment well worth while to the government and be amply vindicated by the better results obtained.

VIII. If any one point in the résumé of the eye work in a base hospital were to be emphasized more than another, it would be the absolute necessity for the most intimate coöperation of the laboratory, radiographic, medical, and specialties departments. It would be but an elaboration of the obvious to indicate the frequency of the various eye signs and ocular derangements and disorders with numerous other local affections or systemic dyscrasias. Syphilis, in its later stages, is so commonly met with in army practice that, in any even slightly suspicious cases (irregular pupils, mild ptosis, paleness of temporal portion of discs, abnormal retinal arteries, etc.), a Wassermann blood test should be insisted upon. The writer has had any number of officers and men, coming to the clinic solely for the purpose of having their glasses changed, who presented such minor signs, often overlooked or passed by as of no particular importance, which, upon thorough investigation, proved to be luetic. Thus this system was developed: During the history taking and preliminary objective examination, should anything abnormal be noted, the patient was immediately conducted by one of the dispensary clerks to the nearby laboratory, with which special arrangements had been made, where he was bled for his Wassermann. When he returned, usually in two days, for his further tests under cycloplegia, the report was already in and one knew definitely how to dispose of the case. Prior to this arrangement it had been found that, in the case of out-patients, should the person not have something definite which he wished to have accomplished, such as an eye examination, he would in all probability fail to return, and moving from place to place with his organization, the report, which was then sent by post, never reached him or arrived so many months after-

ward that the much-needed treatment was dangerously deferred. The same was true to a certain extent of the hospital or bed cases, because the necessity of prematurely evacuating the same often precluded the recording of the report upon their cards and failure to receive their urgently indicated antiluetic therapy resulted.

Urinalyses, blood counts, etc., as well as dental and laryngologic studies, were all done in this speedy, "personally conducted" way, and many factors of utmost importance for diagnosis were thus immediately available for the guidance of the examiner, otherwise days might have been lost in awaiting the returns. This can be done only where perfect coöperation exists, and where the eye department impresses upon the others its own very definite consultation needs.

Barring the infrequently occurring hectic rushes during the times of an especially big "push" at the front, it is possible, by these "hair-trigger" demands for consultation, to have Sweet localizations of the eye cases found positive for foreign bodies done with such reasonable alacrity as to be used for the surgeon's guidance in the matter of their removal, thus insuring intelligent operative interference within a reasonably short time. Patients often are several days wounded prior to admission, and the foreign body so well encapsulated and its tract so densely organized as to preclude efforts at removal by the anterior route, one of the favorite arguments for immediate magnet extractions without awaiting exact localizations. While the writer has had innumerable foreign body extractions, he does not presume to compare his knowledge of this branch of ocular surgery with that of our British colleagues, whose work he has seen and admired. However, in all sincerity he cannot but disagree with them and with their disciples in our army upon this particular, and believes it far better to wait for definite localizations and then, in the guiding light of these findings, to conceive the especial operative approach most likely to

prove successful with the least possible trauma. For this reason, after considerable and impartial trial of both, though formerly prejudiced in favor of the giant magnet, he prefers the smaller magnet unless the foreign body is absolutely visible or localized anterior to the zonular ligament or definitely within the lens.

The author cannot resist the temptation to quote the following record as illustrating the value of routine *x*-ray localization in all cases:

Corporal W. B. A., Co. 20, 4th Reg., U.S.M.C., December 16, 1918.

History. On December 4th a small piece of metal struck his left eye. At Camp Hospital 38 the diagnosis of traumatic iritis was made on December 8th and local treatment instituted. December 10th patient was sent on to Base Hospital 53, where it was noted that the "vision of the left eye was blurred," and an *x*-ray ordered. The next day the diagnosis of "foreign body in the eye" and "acute iritis" was recorded, and after several more days of local treatment the man was despatched to Base Hospital 60, where, on December 16th, vision of 20 30 was noted for the right eye and 1 200 for the left eye. It was noted that the left cornea was hazy, pupil partly dilated, photophobia and lacrimation present, fundus unobtainable with the ophthalmoscope, and concluded that the patient had iridocyclitis. The oculist, going solely upon the qualitative findings of an uncharted radiogram, requested the use of the giant magnet, but was advised by the writer to send the patient into the center for more accurate studies before undertaking magnetic or operative interference. A Sweet localization performed the same day showed a foreign body 1 x 2 mm. below the horizontal plane of the cornea, 11 mm. to the temporal side of the vertical plane, and 13 mm. posterior to the center of the cornea. Inspection revealed a sensitive, photophobic, and lacrimating eye, marked ciliary congestion, contracted pupil, with large, dense, posterior synechia nasally, binding iris to lens, the latter being cataractous nasally and centrally. Owing to this and to a probable large vitreous hemorrhage, no fundus details could be obtained with the ophthalmoscope,

a mere red reflex being present around the limited focus of the cataract. Obviously, after such a localization and after such a length of time the employment of a large magnet, tending to pull the foreign body in any way anteriorly, would have been an ill-advised procedure. It would have demonstrated the presence of an intraocular, magnetizable substance, and would most probably have drawn it into the meshes of the ciliary body, from which situation it would have been most difficult of removal without the complication of prolapse of the latter or the possibility of eventual cyclitis.

If the magnet in the absence of localization had been applied over the probable wound of entrance, which, logically, from the situation of the lenticular opacity and synechia, was nasally, the foreign body might well have been pulled away from its temporal and equatorial position, so ideal for extraction by the posterior route, and dragged into the vitreous or an awkward nasal location. As it was, twenty-four hours later a conjunctival flap was made and a sclerotomy performed at the temporal equator, and just below the tendon of the external rectus the fine sterilized point of the small magnet inserted, and the foreign body removed without mishap, all in the space of two or three minutes and without trauma or pain.

But a week has elapsed, and yet all the primary iritis has disappeared and the post-operative reaction has subsided, while the vision, owing to the partial absorption of the vitreous opacities, has improved to 4 200, though the circumscribed traumatic cataract will probably preclude any further great improvement.

Whether it be due to the excessive smoking prevalent in the army, or to the exposure to dust when on the march, the author has noted with surprise the prevalence of nasopharyngeal catarrh and associated eye conditions, more especially stenosis of the nasolacrimal duct and dacryocystitis. Thus the adjoining laryngologic department has aided greatly in the rather gratifying results, and he is inclined to feel, from the excellent opportunity to check up such cases, that the problem of curing or relieving these people is 50 per

cent. one of rhinologic diagnosis and corrective measures. Sinusitis in army work does not seem to have played the ocular rôle that it does in civil life, and there has been but little opportunity at this clinic to add anything of interest to the work of Markbreiter, Reber, and others who have rather thoroughly explored the subject.

On the contrary, dental causes for eye diseases, especially that extraordinarily severe episcleritis, seroplastic iritis, and uveitis of non-specific origin, met with so frequently in army practice, have been far commoner than the writer ever realized, from previous experience in civil practice, could be the case. Perhaps this is due in part to the average neglect of teeth in young men of military age, possibly to the high protein diet and fondness of sweets, or to the mild, oft-repeated trauma to the teeth from the mastication of the hard crackers which form part of the ration. At any rate, the dental department has aided the eye clinic very materially in the discovery of these etiologically responsible foci of infection, and by the eradication of the same the relief and cure of the most obstinate cases.

While the press of routine work has prevented such accurate studies of head injuries as were conducted by Colonels Lister and Gordon Holmes, R.A.M.C., yet with the aid of the neurologic department much interesting data was gleaned, most of which, however, seems too immature for publication. As in civil work, the neurologists' aid proved invaluable in the obscure optic atrophies, pupillary abnormalities, hyperemic or edematous discs, hemianopsias, extra-ocular muscle paralyses, etc., and many difficult cases of multiple sclerosis, general paresis, tabes, etc., referred primarily for eye conditions, were diagnosed. Also of extreme value to the service was the early neurologic consultation and advice in regard to the detected malingerers, especially in the determination of the necessity of removal from

dangerously responsible positions of officers admitted as eye cases, and found to have incipient tabes or general paresis.

The importance of the medical consultation is too vast to be adequately summed up in such a superficial and informal paper if we take into consideration arteriosclerosis, nephritis, diabetes, tuberculosis, etc. At the moment, what impresses the writer most is the importance of ascertaining the condition of the heart and lungs in cases primarily sent in because of "gassed eyes," and who were wont to develop pneumonias or cardiopulmonic complications far outweighing the local kerato-iritis or conjunctivitis for which they were admitted to the eye ward.

IX. *Difference Between Military and Civil Ophthalmic Practice.*—There are so many conditions which determine this difference that it is difficult to make accurate deductions from the data available, and misleading to draw too many conclusions therefrom.

In addition to passing more or less rigorous physical examinations prior to admission, the subjects are drawn from an age which fails to embrace the many congenital anomalies and ocular maladies met with in youth, and at the same time rules out of consideration most of those changes which are thought of as the accompaniment of advancing years. In its place the element of men physically strong, of an age given more or less to dissipation, crowded into abnormal habitations, and as a class using their eyes but little at the near point, must be considered. Then one must bear in mind that many have seen service before, have lived in tropical climes for long periods, and have interesting previous medical histories. This is especially so in the draft army, almost every nationality upon the face of the globe is represented, so that tendencies toward if not definite manifestations of ocular weaknesses characteristic of certain races may exist latently, and in the fertile soil of an exposed,

non-resisting eye, find an ideal site for the expression of its most pronounced form.

As far as the existence of any great, general, outstanding difference between average eyes in the regular army, the national guard, and the draft army is concerned, the writer, though assiduously applying himself to the task of discovering such, has failed to note any, the same character of unrecognized, old conditions (pigmentary degeneration of the retina, monocular primary optic nerve atrophy, central choroidoretinitis, etc.) having been passed with about an equal ratio by the examining boards for all these units.

POSITIVE ASPECTS: *Refraction.*—Statistics, gleaned from investigations among civilians, reveal the following percentages (Thorington):

Hyperopia, 20 per cent.; hyperopic astigmatism, 5.5 per cent.; compound hyperopic astigmatism, 44 per cent.; myopia, 1.5 per cent.; myopic astigmatism, 1.5 per cent.; compound myopic astigmatism, 8 per cent.; mixed astigmatism, 6.5 per cent.; emmetropia, 13 per cent.

In army work the average age limits, previous physical examinations, and rejections of the unfit have so modified these figures that, of 3645 consecutive cases checked over by the writer, the following tabulations were obtained:

Hyperopia, 700; hyperopic astigmatism, 510; compound hyperopic astigmatism, 1345; myopia, 165; myopic astigmatism, 215; compound myopic astigmatism, 370; mixed astigmatism, 300; presbyopia, 40.

The author places considerable reliance on these figures because of the standardized examinations which yielded them, a cycloplegic being routinely employed in all cases, and there being in consequence no possibility of undiscovered latent errors which might transform a simple into a compound hyperopic astigmatism, or a pseudomyopia into hyperopia. In civil practice one not infrequently prescribes glasses for the patient's convenience or comfort, when, if it

were necessary, the patient could go about and perform his duties without the same, although with less ease and more fatigue. Not so in military practice, men being needed so badly at the front that often after mere preliminary tests it was decided that he could "carry on" with his inconsequential symptoms and return at a less active time for examination into his low degree of refraction error. Thus it was uncommon to prescribe convex or concave 0.25 diopter spheres or cylinders save where "against the rule," or other medical conditions being eliminated, the source of extremely annoying symptoms or the occupation (field, clerk, photoggrapher, observer, etc.), of such a nature as logically to demand correction of the minutest refraction anomalies.

Muscle Imbalance.—In average army work, compared with civil practice, there is but little of the ordinary muscular insufficiency, such as weakness of the converging group or its contrary, spasticity of the internal recti, and when encountered is seldom of sufficient degree to warrant orthoptric exercises, prisms, or more drastic interference. More than likely the out-of-door life, the increase in general muscular tonicity, the longer sleep hours, the lack of prolonged close work, and the substitution of great distances and more soothing landscapes for the former office desks or vivid street scenes brought about this change.

Very striking observations have been made, however, upon the state of the extra-ocular muscle balance of aviators when in high altitudes, or when during tests they were deprived of the necessary amount of oxygen, and the diplopias, which were such a handicap to some in aërial combat at great heights, have been to a great extent obviated by an apparatus to supply oxygen to these individuals when in a rarefied atmosphere. The writer will not dwell upon the very interesting tests which have been evolved to try the effect of gradually exhausting the oxygen, when the subjects are endeavoring to sight and orientate with precision, because

the Medical Research Laboratory, with Colonel Wilmer in charge, will undoubtedly present the subject exhaustively.

LIDS.—Blepharospasm was commentably noted after mustard-gas exposure, and was responsible, in the author's opinion, for the erroneous conception in the minds of many physicians of the gravity of gas conjunctivitis. Long after the latter had subsided this orbicularis spasm would of itself prolong the conjunctival and corneal stasis and irritation and produce chronic photophobia and venous congestion. When this was explained to the person of average intelligence, it was found that he could, by exercising self-control, prevent the same and that his condition would then clear up within a few days. Others persisted for months, producing more of a traumatic or mechanical conjunctivitis than one could blame upon a primary chemical irritation.

Blepharophimosis was particularly noticed after wounds of the globe and lids necessitating enucleation and blepharoplasty, the lids often overlapping entirely, usually with a marked spastic entropion of the lower lid, and rendering dressings very difficult.

Great edema of the lids was observed in a few cases of anthrax and erysipelas of the face.

Congestion occurred after prolonged gas blepharospasm, the subcutaneous vessels appearing tremendously distended and tortuous.

Marginal blepharitis of the subacute variety was very frequently observed. It was not of the seborrheic form, and the lids were but slightly thickened, though small ulcers and a very red, excoriated surface were revealed when the crusts were softened and removed. This was often found in conjunction with a high degree of hyperopic astigmatism, usually "against the rule," and cleared up within four or five days under appropriate local treatment and correction of the refraction error. A number of cases were seen in which the roots of the cilia had been destroyed by a severe and

probably neglected blepharitis marginalis in childhood, the lashes being entirely wanting. One patient, sent in for "granular lids," had dense accumulations of the nits of pubic lice about the bases of the cilia, further inspection revealing them in his long, tousled hair, whence they had probably gravitated to the lids.

Herpes.—Less herpes zoster was remarked than in civil practice of like volume, but numerous cases of simple herpetic lesions of the lids were encountered, usually associated with like manifestations on other parts of the face and in the corneal epithelium of a transitory nature and easily healed.

Syphilis.—There was one interesting case of long standing, atypical syphilitic tarsitis extending to the lid margin, which rapidly cleared up under an antiluetic regimen.

Injuries of the lids represented a very common form of wounding, one or both lids being incised, lacerated, contused, or entirely carried away in almost all the eye injuries, and some type of blepharoplasty had to be performed one or more times upon most of these men. Often small particles would be embedded in the lid, occasionally working out themselves by way of the conjunctival culdesac. When not directly injured, ectropion would not infrequently set in after face wounds and burns.

A rather unusual and undoubtedly benign tumor of the lid was observed, but no definite pathologic examination was made. History and description follow:

Private B. B., aged twenty-six years. Infantry.

History.—September 19, 1918. At ten years of age a growth appeared beneath the right upper lid and grew so large that it covered the entire eye, its removal by knife being necessitated. When eighteen he was called to the Russian army, and after being in service about two months, was sent to a hospital and discharged because of poor eyes. About one month before examination, the same lid began to

itch and another growth appeared, small at first, but increasing since. When exposed to bright sunlight, there is a sharp pain over the right eye, like sticking needles. Last night there was slight bleeding from the lid. There is an almost constant, sharp ache in the right side of head. The vision of the right eye is very poor. During the past few days there has been an itching sensation under the left lid, very similar to that of the right which preceded the appearance of the growth. Has noticed also that recently there has been a white, filmy secretion from the left eye. Smallpox in childhood. Mother became blind in both eyes following an operation, while in Russia, eight years ago.

Present Condition.—In the right superior tarsal conjunctiva, at the junction of the inner and middle third, about 2 mm. inferior to the superior margin of the tarsal cartilage, there springs a narrow, grayish pedicle from which is suspended, very much in the manner in which the kidney is held by its pelvis, a reniform, trilobular, bluish-red tumor, about 8 to 10 mm. long, 3 mm. broad, and 3 mm. thick, its flat side being in apposition to the globe, its lobulated side opposite the lid. The surface of this tumor is smooth, glistening, and very delicately stippled in places. The conjunctiva overlying the tarsus is uniformly congested in appearance.

In the left superior tarsal conjunctiva, near the inferior nasal margin of the cartilage, astride the sulcus subtarsalis, there is a small, sessile, nodular growth which he says has been present for many years; this is brownish-red, has a buff-white center, and is approximately about 3 to 4 mm. in diameter, with an elevation of about 2 mm.

Advise excision of tumor and its pedicle, followed by cauterization and curetage of the region of its attachment. V.R.E., 15/200; L.E., 20/20—.

September 20, 1918: Tumor of left eye described above proved to be a chalazion.

Right eye: Pedicle of tumor must have been twisted spontaneously, for tumor sloughed off and the operator had simply the root of the latter to dissect out. This was done and the site cureted and destroyed with Paquelin cautery.

September 27, 1918: "Homatropin cycloplegia."

Fig. 1.—Teratoma of the lacrimal gland.

Ophthalmoscopy: Hyperemic papillæ and infiltration of perivascular lymph-spaces.

Static refraction: O.D. sph. $+.75 \bigcirc$ cyl. $+.75$ ax. $110^\circ =$ 20/70. O.S. sph. $+.75 \bigcirc$ cyl. $+.75$ ax. $85^\circ = 20$ 40. Ordered full correction for near.

Diagnosis: Compound hyperopic astigmatism. Probable bilateral retrobulbar neuritis.

Advised Wassermann, urinalysis, rhinologic and neurologic consultation.

Post-traumatic ptoses were occasionally noted, aptly illustrated in the case of Private C. E. E., quoted under retinal injuries.

Lacrymalia.—Of far more common occurrence than encountered in practice at home were the various forms of stenosis of the nasolacrimal apparatus. These were usually found due to chronic hypertrophic rhinitis and thickening of the nasal mucosa, no doubt in turn caused by the exposure, dust, and excessive smoking, but occasionally they resulted from injuries or burns either obliterating the puncta or drawing the lids away from their bulbar apposition. Sometimes old cases of former acute dacryocystitis, which had been incised, were seen, and tiny fistulæ were present on the face over the inferior portion of the sac, where they had remained for years.

An interesting case of tumor of the lacrimal gland was studied and notes of the case are here given (Fig. 1):

Private P. J. O., aged twenty-one years. Machine Gun Company. May 27, 1918.

History.—Patient was admitted to-day from Field Hospital No. 101, with the diagnosis "tumor of the left upper eyelid." He stated that when he was five years old his mother noticed for the first time a large, coarse hair protruding from the palpebral fissure of the left eye, near the external canthus. This apparently grew down from beneath the left upper lid. Nothing was thought of or done about it other than cutting it off with scissors, from time to time,

when it became so long as to be conspicuous or inconvenient. About one year ago the patient first noticed the tumor, half its present size, of an orange color, then, as at present, one day white and the next day red, and lying in the left superior conjunctival fornix. Since then he has remarked its rather rapid, though otherwise uneventful, growth. Though having a "spongy feeling," it has never produced more than an occasional blurring of vision; other than this his medical history is negative. Struck in the left eye with a hat-pin two years ago, but without serious results.

Present Condition.—There is a large, pedunculated, multilobular tumor, of firm consistency, convex anteriorly but molded concavely posteriorly from its pressure upon the globe, on which it rests and against which it is held by the lid. Originating from the region of the accessory lacrimal gland, it extends into the palpebral fissure for about 7 mm. and is quite conspicuous, apparently interfering with the left eye's supraduction and abduction. Its surface is moist and its color a grayish salmon pink. Subsequent visual, ophthalmoscopic, and refraction tests negative.

June 4, 1918: Under local anesthesia the tumor was dissected from its attachment in the lacrimal gland, the incised conjunctiva of the retrotarsal fold being brought together by a suture. Recovery was uneventful, and the patient returned to duty within a few days.

On sectioning the tumor there was exposed to view what appeared to be a small, sharp tooth, possessing a perfect covering of glistening white enamel. There was a definite outer fibrous capsule, with what seemed to be fibrous septa between the various lobes, and an inner yellow line, presumably fat; there was some definite arrangement of the whole, the various tissues being segregated as far as the eye could see. As it was not cystic, dermoid cyst was ruled out and the surgical diagnosis of teratoma was made, the specimen being sent to the pathologist, Captain Kline, who placed it in a decalcifying solution for later sectioning and report.

Note from Pathologic Laboratory: "Specimen consists of a tumor mass about 1.5 by 0.8 cm., solid. On section the mass is found to be contained within a thin fibrous capsule, which is attached to a small mass of spongy tissue which

suggests glandular structure. The tumor is composed of a mass of yellowish fatty tissue embedded in which there is a tooth-shaped mass of bone-like tissue. Microscopic section shows areas composed of loose connective tissue with smooth muscle cells scattered throughout. In addition to these cells there are striated muscle cells showing branching. Embedded in the connective tissue there is an area having the appearance of normal bone, triangular in shape. There are scattered osteoblasts visible, and in one corner true Haversian systems. In this region there is a thin layer of flat cells covering the bone. In areas embedded in the connective tissue there are islands of fat cells. In places covering the various tissues mentioned above there is a syncytial-like layer of cells. Diagnosis: Teratoma."

While the author has seen lacrimal gland neoplasms of other varieties, he is inclined to believe that teratoma of this organ is a rarity, inasmuch as there is no reference to it in the scant but reliable literature upon the subject. MacCallum mentions teratomata of the orbit, but not of the lacrimal gland. Fuchs gives but a line or two relating to the neoplasms found in this situation. With his characteristic thoroughness, de Schweinitz throws more light upon the subject. To quote from his text-book, eighth edition: "Adenoma, fibroma, myxoma, adeno-angioma, epithelioma, carcinoma, osteochondroma, lymphomacylindroma, and sarcoma occur. Tubercle, in the form of a small, almond-shaped tumor, has also been reported in this region. Cysts and concretions (dacryoliths) occur. The concretions are contained in the excretory ducts, and are composed of concentric, chalky masses (Levi). According to Warthin, the majority of lacrimal tumors are, most probably, mixed tumors of endothelial origin, similar to those of the parotid and submaxillary glands. They tend to form cartilaginous, hyaline, and myxomatous tissue, and their malignancy is relatively slight."

Tumors of the caruncle were not infrequently met, uniformly of a benign, papillomatous order.

Conjunctiva. The most important single conjunctival aspect of war ophthalmology was acute chemical conjunctivitis, or that form of conjunctival and corneal burn due to exposure to the so-called "mustard gas." The seriousness of this affection has been greatly overrated, its subjective symptoms immensely exaggerated, and, of the many hundreds of cases which the author has personally examined and treated, not one has had ocular sequelæ of importance.

Usually there is simply the picture one would have in an acute catarrhal conjunctivitis, but not infrequently there is a super-added ciliary congestion, evidence of corneal irritation, or definite haziness of the corneal epithelium from tiny infiltrates, with slight serous iritis.

These cases manifest more photophobia and lacrimation, which will persist unless atropin is employed. In the severer cases, seldom met, one sees excoriation of the skin of the lids where the gas-impregnated tears have overflowed, great chemosis, and in the area of the palpebral fissure the cornea is yellow, degenerated, opaque, possibly partially desquamated, there often being a superficial slough. The photophobia and consonant iritis are very marked.

In July, 1917, shortly after the first use of this gas against the British and French, and before our own men had gotten into action, Colonel Ashford, the then Chief Surgeon of the First Division, our only troops in France, asked the writer, who was making a round of the various Allied hospitals, to look into the matter of the prognosis and treatment of the ocular manifestations, the author reporting to him, under date of August 27, 1917, as follows:

"August 27, 1917.

"1. In compliance with your request that I secure the latest data upon the reported eye burns with the so-called 'Mustard Gas,' I have gone most particularly into the sub-

ject during my recent trip for the purpose of minute study of French and English eye surgery.

"2. I have seen some very bad burns from this gas, notably of the genital parts, perineum, etc., but the situation, as regards the eyes is much brighter, for with the masks on no burning occurs, and with mask off merely the conjunctival burn one would expect from any severe chemical irritant, such as lime. The cornea is but seldom affected, and then only by a superficial ulceration quite readily combated by the usual therapy, whereas the danger of ultimate symblepharon does not seem to be feared by either English or French oculists, though definite observations upon this point are, quite naturally, a bit premature.

"3. Treatment differs in no wise from the treatment of chemical burns in civil practice. Some cooling, cleansing collyrium, such as sodium biborate, boracic acid, or normal salt; the instillation, every three or four hours, of a bland oil, for example, liquid petrolatum (used by the British), castor oil, or warmed, semifluid, plain or borated white vaselin; cold compresses (unless cornea is involved, when atropin and hot compresses are indicated), and, if the local pain is intolerable, holocain hydrochlorid collyrium. It would be well to separate the lids from the globe twice a day by passing a glass rod between the palpebral and bulbar conjunctivæ and thus prevent any cohesion of the transitional folds in the fornix conjunctivæ.

"4. In this connection it is not amiss to warn against a French practice (also condemned, and rightly, by the British surgeons) of using a cocain collyrium to relieve the pain, inasmuch as this drug softens the intercellular cement of the corneal epithelium, elevates the latter, and, after a while, partially or totally exfoliates same. This may account for the ulcerations which have occurred.

"5. As remarked in section 2, the gas mask prevents the eye burns, and is the only prophylactic yet advanced. Therefore, the men should be particularly warned against omitting its use or adopting the method of the English "Tommy," who often pinches the mask to his nose and leaves the eyes exposed for the purpose of clearer vision and comfort."

Despite this, months later, when our troops first went into

action, a circular was sent out admonishing army surgeons to refrain from using any oily substance and moist compresses, which would, the "Powers that be" seemed to think, increase the burn, and telling them to employ "Brooks' solution" as an irrigant.

The writer obeyed instructions, but, being dissatisfied and believing that the burning power of the gas was soon expended and that the treatment outlined was insufficient and tended to protract recovery, he tested out a score or more of the worst cases, in each convoy of patients, with the treatments as originally advocated by him; the marked and rapid improvement in the latter, as compared with the former, more than justifying the contention. Therefore he was relieved when, on September 9, 1918, a circular was dispatched from headquarters to all hospitals in the American Expeditionary Forces advising practically the identical treatment as that which he had pursued all along, though he is still practically alone in the use of the holocain, which does seem so valuable in these cases, and the use of which should be insisted upon where indicated. The very complete army circular relative to the subject is here quoted:

"Headquarters, Medical and Surgical Consultants,
A. E. F., A.P.O. 731, France.
Division of Ophthalmology, 6 September, 1918.

"CIRCULAR NO. 1.

"1. *Gassed Eyes.*—Treatment of eyes injured by those gases which produce a chronic conjunctivitis (mustard gas—dichlorethyl sulphid):

"The earliest possible treatment is necessary to lessen the duration of the disability. The early treatment should be given at the first bathing. It should consist of a thorough flushing of the conjunctival sacs with a 1 per cent. solution of sodium bicarbonate, preferably warmed to body temperature. Care should be exercised to see that both the upper and lower culdesacs be thoroughly cleansed.

"Following this treatment the eyes should be washed out,

every four hours in severe cases, with either solution sodium bicarbonate, 1 per cent. normal saline solution, or a saturated solution of boric acid, and a drop of liquid albolene should be instilled after each washing. Olive oil may be used when liquid albolene is not available.

"In the more severe cases corneal involvement of greater or less degree is common. This takes the form of a roughening and opacification of the corneal epithelium in the area of the palpebral fissure. Infection through this sodden epithelium may take place, leading to ulceration, and produce permanent damage to the eye, and may even cause a complete loss of sight. Such cases always show marked photophobia and usually a contracted pupil.

"In such cases a solution of atropin sulphate, 1 per cent., should be used sufficiently often to keep the pupil dilated, and the eyes should be shaded from the light but never bandaged. As soon as the corneal or uveal disturbance has subsided the atropin should be discontinued, and it is advisable to get the patient up and accustom him to the light, to avoid long hospitalization of such cases. Secondary infection of the conjunctiva is common, and may be treated by a solution of argyrol, 20 per cent., instilled three or four times a day. Self-induced relapses are not uncommon and should be watched for.

"In the later stages, when photophobia persists without signs of conjunctival irritation to account for it, it is advisable to use cold douching of the eyes two or three times a day, and to employ the patient in some suitable light occupation.

"Where corneal involvement is marked, the ophthalmic consultant should be asked to see the case."

Hyperemia of the conjunctiva was rather universally noted, and probably explicable on the grounds of exposure to dust, wind, tobacco smoke, and powder smoke. Certainly it did not seem to be influenced by the correction of existing refraction errors.

Follicular conjunctivitis was very common. As in the case of children in institutions, schools, and asylums, this was undoubtedly due to overcrowding, the vitiated dust-

and tobacco-laden atmosphere of barrack, tent, and dug-out, the gases from the stoves and tobacco smoke, and was more commonly observed in the colder months. The writer is certain that this was more frequently met here than in an equal number of healthy men of the same age at home.

Phlyctenular conjunctivitis was rather seldom seen, and when found, was bizarre in its course and atypical in its appearance, being much milder than the ordinary conjunctivitis eczematosa with which we are all so familiar.

Acute catarrhal conjunctivitis, Koch-Weeks bacillus conjunctivitis, and pneumococcus conjunctivitis were encountered with relative frequency, and occurred in little epidemics in the same companies and training schools, while gonorrheal ophthalmia was seen but twice or thrice, a tribute to the efficacy of the army's venereal prophylaxis system.

So many cases required prolonged atropinization that a moderate degree of atropin conjunctivitis was not unusual, though it caused no concern whatever.

As above mentioned, simple herpes of the conjunctiva was noted from time to time, but herpes zoster ophthalmicus was very rare.

Emphysema of the conjunctiva occurred rather often after orbital, nasal, or sinus wounds, and occasionally after orbital operations for the removal of retrobulbar foreign bodies which had caused communication with one or more of the sinuses.

Chemosis and ecchymosis of the conjunctiva were seen daily, the former accompanying many of the "gassed" eyes, the ordinary infections and the trauma of the lids or globes, even if no more than the spattering with small particles of gravel, the latter occurring after traumas, explosions of nearby shells, chest squeezes or crushes, and with scleritis, severe iritis, or gas bronchitis—usually with the iritis.

A traumatic form of conjunctivitis, occurring after the explosion of nearby grenades or shells, seemed to be prac-

tically uninfluenced by treatment and ran a brief course to complete recovery.

Symblepharon seldom occurred save as a very circumscribed local process, and almost always accompanied wounds of the lids and eyes. In the former there would be, as a rule, a linear adhesion behind the site of the laceration, which would necessitate a minor plastic operation before the fornices would be free to accommodate the prosthesis. In the latter there would be such ragged, sector-shaped, extensive loss of bulbar conjunctiva that it was well-nigh impossible to approximate all the edges and prevent some spot of adhesion to the palpebral reflexion.

Acute pemphigus of the conjunctiva was met with but once, but the case presented unusual opportunity for study and follow-up, and would seem worth noting in some detail:

Private C. L. E. Infantry. July 31, 1917.

History.—Patient complains of a sore and inflamed left eye. This eye has been a source of trouble during the past five years. There have been periods of severe pain and inflammation, with intervals of apparent normality and freedom from any subjective or objective symptom of disease, except that the vision has gradually failed in both eyes, though to a more noticeable degree in the left. He remarks that it is this eye which has been, on past occasions, considerably traumatized from one cause or another. He has had measles, mumps, and pertussis in childhood, and prior to five years ago was thought to have "heart trouble." Has had gonorrheal urethritis five times, the last attack four months ago. In 1909 had 12 "chancroids." Denies having had lues. Father, mother, and three sisters living and well. One sister died of pertussis. No history of tuberculosis. One uncle had a cancer. Father and an uncle each lost an eye from causes unknown to this patient.

Present Condition.—Physical examination: Thorax and abdomen negative; genitalia; scars of numerous chancroids upon glans penis; extremities, some scars over right tibia; reflexes, generally increased, especially the patellar.

Left eye: Marked swelling of the lids, blepharospasm, and photophobia, with profuse lacrimal discharge, as well as a marked mucopurulent, conjunctival secretion. The latter has become caked and dried upon the cilia, matting them together, while hard crusts have formed along the margins of the lids and between the lashes. There is a decided blepharitis marginalis, with a few small hordeoli, probably an ectogenous infection from the constant bathing of the Meibomian orifices by the conjunctival secretion. The palpebral conjunctiva is tremendously engorged and swollen, the surface being red and beefy in appearance, though moist and fairly smooth, while there seems to be no undue hypertrophy of the lymphoid elements or the retrotarsal transitional folds in the fornix. The bulbar conjunctiva is extremely congested, but not unduly chemotic. It is interesting to note a large, superficial ulceration of the bulbar conjunctiva, fairly circular in outline, and about 5 mm. in diameter, immediately inferonasal to the cornea and in juxtaposition to the limbus. As a matter of fact, the ulcer appears to extend into the cornea for about 1 mm. beyond the margin, and there is a grayish or grayish-yellow infiltration, probably round cell, which extends into the substantia propria, and mars the transparency of the otherwise healthy cornea. There are two small ulcers in the bulbar conjunctiva near the inferior fornix.

Therapy at outset: Atropin and other local remedial measures indicated by the symptoms.

At this time three etiologic factors presented themselves: Gonorrhea, lues, and some rare leptothrix or other fungoid infection; in fact, some of the earlier smears seemed to support the latter view. Repeated smears were negative for any definite bacterium, and presented not the slightest evidence of a Gram-negative, biscuit-shaped diplococcus. Lues was partially ruled out by a negative Wassermann. Cultures proved negative. Various modifications of and actual changes in the local and systemic treatment were tried, but the condition proved most refractory to all, still more definitely ruling out gonorrhea and lues.

August 4, 1917: Smear from ulcer failed to reveal anything definite; there were many polymorphonuclear leukocytes, a few epithelial cells, much fibrin, a few cocci, bacilli of a non-

descript variety, and something that was suggestive of a streptothrix. Urinalysis and blood tests yielded no positive findings.

August 26 and 27, 1917. Negative for all higher bacteria or fungi, for the gonococcus and tubercle bacillus.

August 28, 1917: There is still considerable blepharospasm and local irritation. The two ulcers noted at the inferior conjunctival fornix have practically healed. In addition to the main ulcer, noted upon the first examination, there is a small, incipient, superficial ulceration, about 5 mm. superonasal to the cornea. Smear from this fresh ulcer negative.

September 1 and 2, 1917: More corneal ulcers noted, from which five new smears were made. Negative.

September 4, 1917: Examiner first impressed with the possibility of a pemphigoid affection, because of observing the small remnant of a veil-like film still attached to the edge of a very new ulcer and which might represent the erstwhile covering of a broken bulla.

September 5, 1917: Dermatologist (Major Wile) called in consultation: the following note was given by him: "General examination of the patient and a careful consideration of the history bring to light a doubtful infection, possibly mixed, in 1909, not followed, however, by any recognizable secondary lesions. On the glans penis are numerous shallow scars, the result of previous ulcerative lesions, and over the right tibial region there are a few, small, punched-out scars, the result of some circumscribed ulcerative process. The absence of peripheral pigmentation suggests that these scars are probably the sequel to a pustular infection other than gummatous. The reflexes are markedly exaggerated in the tendons of both the arms and legs. This latter finding, together with the history of the periods of depression and nervousness, is somewhat suggestive of a cerebral involvement. The local process in the eye impresses me as a type of the rare, recurring, bullous erythemas, which are, occasionally, limited to this membrane alone. A differential diagnosis between this condition and a recurring, superficial, ulcerative syphilid would, in my opinion, be possible only by definitely eliminating the latter. For this reason I would suggest lumbar puncture and a repeated blood Wassermann. In the event of the process being a syphilid, the prog-

nosis is admirable, and for this reason a thorough therapeutic test would also seem to be indicated, even in the absence of other findings. The prognosis, in the case of a bullous erythema, is not good, particularly in the absence of any exciting cause."

September 11, 1917: Spinal fluid Wassermann negative. Cells varied from 0 to 3 per c.mm. Pandy's test negative. Lues now seems definitely excluded.

September 12, 1917: A fresh bulla having formed upon patient's conjunctiva, the dermatologist was again called, this time unequivocally diagnosing bullous erythema. Sodium bicarbonate irrigations to the eye and citrate therapy internally were tried, with but slight temporary improvement. Later, Fowler's solution internally produced no better results.

October 17, 1917: Bullæ have been recurring at somewhat longer intervals, on both bulbar and palpebral conjunctiva, sometimes, as to-day, upon both simultaneously. In the interim the conjunctiva has become drier and drier, the palpebral being boggy and of a dull, fleshy color, the bulbar of a dusky, brownish-red hue, and both have a decided lackluster appearance. The inferior retrotarsal fold is practically obliterated, and there is definite traction between the palpebral and bulbar membranes when the lower lid is everted and the patient told to look upward.

Although the author has seen several cases of old pemphigus conjunctivæ, in which cases the changes have gone on to an unmistakable picture familiar to any oculist of a large dispensary experience, yet the process has always affected both eyes. However, the diagnosis of bullous erythema, probably pemphigoid, was made, and the patient evacuated with the advice that he be shipped home and honorably discharged. From this time until June 15, 1918, he went from one military hospital to another in the United States, probably with the forlorn hope of having the condition cured; many varied diagnoses were offered. Finally, on the date last mentioned, his diagnosis was changed to pemphigus of the conjunctiva, left, and he was honorably discharged from the military service.

The recorder realizes that this is a rare conjunctival dis-

ease, and that it is still more exceptional to have only monocular involvement, but he reports this case principally because he feels that an accurate description of the usually unrecognized incipient stages of the malady may not be unwelcome.

Pterygium and pinguecula, especially the former, occurred with great frequency, the patients, as a rule, hailing from Texas, New Mexico, or the Southwest, and in truck-drivers, ambulance men, motor-cycle couriers, or those exposed to the wind, dust, and inclemencies of the weather more than the ordinary.

Injuries of the conjunctiva were usually associated with graver destructive wounds of the globe as well, but now and then one would see cases of abrasions, rents, and slits, subconjunctival embedded foreign bodies, occasionally magnetizable, but usually dirt, stone-chips, etc. As a rule, the prognosis was excellent.

Cornea.—Arcus senilis, usually incomplete, was so often found in the routine examination of the eyes of young men that its name seemed rather paradoxic.

Herpetic keratitis of the superficial form, and leading to dendritic ulceration, was fairly often remarked, occasionally associated with dental caries. Herpes zoster, again emphasized, was seldom seen.

Foreign bodies in the cornea were extremely common, both of the type seen in civil and industrial life (emery, cinders, thorns, etc.) and those due to distant explosions, with scattering of minute particles of débris and embedding of bits of dirt, sand, gravel, quartz, glass, wood, steel, copper, or aluminum in the cornea, usually deep in the substantia propria. Nearby explosions and accidents would often force small powder granules, either carbonized or only partially burned, into the cornea or through it, and it was a not infrequent spectacle to see a man with his entire cornea studded with these granules, and even his iris and lens peppered with

the same. Deep-seated, non-magnetic, corneal foreign bodies were often most difficult of removal, as instanced by this rather average case.

Private G. O. R., aged twenty-two years. Infantry. July 6, 1918.

History.—June 21st shrapnel exploded near him and a particle of stone lodged in left eye. Vision in left eye is greatly impaired, but has been so as far back as he can remember. With right eye distant objects seem to jump and dance. Eyes are very sensitive to sun. Had "granulated lids" when a child. Childhood diseases. Father has weak eyes. Ears are being treated at present.

Present Condition.—Three tiny, punctate, iridescent, quartz-like, non-magnetic foreign bodies embedded in the posterior layers of the cornea of the left eye. Removal unsuccessfully attempted. Deemed advisable to leave in situ. V.R.E., 20/40; L.E., 20/200. Atropin, 1 per cent.

July 9, 1918: Ophthalmoscopy: Negative save for slight hyperemia of both papillæ, particularly the left. Static refraction: O.D. sph.+1.75 ⊃ cyl.+25 ax. 95° = 20/30. O.S. sph.+3.50 ⊃ cyl.+1.75 ax. 165° = 20/50.

July 15, 1918: Foreign bodies removed from left cornea.

Burns of the cornea were usually of the chemical type referred to and described above under "Mustard Gas," but occasionally molten metal or the "Flammenwerfer" were to blame. An example follows:

Private M. R. R., aged twenty years. Infantry. July 13, 1918.

History.—Left eye burnt by hot ashes from exploding shell, June 7th. At the same time a considerable amount of dirt was lodged in right eye. Vision of left eye is greatly impaired. When he lies down he is cognizant of dull frontal headache, which generally comes on during afternoon. When exposed to sun, eyes lacrimate excessively. Childhood diseases. F.O.H., negative.

Present Condition.—Left eye: Center of lower lid margin shows a slight indentation and cicatricial change, and at that

site the cilia are wanting. The cornea shows nebulæ and central, vertical, linear maculæ, as though from previous ulceration.

July 17, 1918: Ophthalmoscopy: O.D.: Negative. O.S.: Details blurred, owing to corneal opacities. Photophobia, and lacrimation. Static refraction: O.D. sph.+5.00 ⊃ cyl.+ 1.00 ax. 80° = 20/20. O.S. sph.+5.25 ⊃ cyl.+.75 ax. 105° = 20/40.

Diagnosis: Compound hyperopic astigmatism, bilateral.

Corneal wounds of every type were met with, ranging from jagged tremendous rents with evulsion of the intraocular contents, to small incised or punctured wounds, with or without prolapse of the iris. These were usually due to grenade accidents, and there were often foreign bodies intraocularly or intraorbitally. Sometimes there were mere denudations of the epithelium or more severe abrasions involving all but the endothelium, and usually followed by panophthalmitis from the infection of the exposed opened lymph-channels.

Sclera.—The marked frequency of scleritis and episcleritis, together with the severity and prolonged course, must not go unrecorded, because the writer and his associates have been impressed with the disproportionate prevalence of this affection among soldiers as compared with civilians. The appearance of the lesion differs in no great degree from that encountered at home, except that iritis and cyclitis more commonly complicate matters; there is more apt to be subconjunctival ecchymosis, hyphema often appears, and the patient presents an appearance of much more intense suffering than in the ordinary types. Dental disorders, more commonly than other things, have been found in conjunction with this condition, and institution of remediable measures for these have wonderfully accelerated the cure of the ocular trouble.

Wagoner D. U. M., aged twenty-four years. Engineers, May 28, 1918.

History.—About a week ago right eye became inflamed and the lids would stick together in the morning. Three or four days subsequently the left eye followed suit, the right, in the mean time, clearing up. Says he has been treated with boric acid, atropin, and argyrol.

Present Condition.—Over the temporal sector of the left eyeball, extending from the limbus to the external canthus, is a swollen, congested area, having the appearance of an episcleritis, inasmuch as it is circumscribed, elevated, of a purplish-red color, and unaccompanied by conjunctival secretion, though the palpebral conjunctiva is somewhat "boggy" and relaxed as if it had been previously inflamed. Atropin, 1 per cent.

June 1, 1918: Ophthalmoscopy: Negative. Static refraction: O.D. sph. $-.25 \bigcirc$ cyl. -1.00 ax. $165^\circ = 20/20$. O.S. sph. $+.75 \bigcirc$ cyl. $+1.00$ ax. $85^\circ = 20/30$.

Diagnosis: Right eye: Subacute conjunctivitis, compound myopic astigmatism. Left eye: Episcleritis, compound hyperopic astigmatism.

Foreign bodies in the sclera, embedded in Tenon's capsule, and beneath the tendinous invaginations of the recti muscles, have been commonly observed and removed, these usually being simple and uneventful cases. Illustrative of this:

Second Lieutenant W. H. B., aged twenty-nine years. Infantry. March 9, 1918.

History.—A bit of metal from an exploding hand grenade struck him in the left eye yesterday.

Present Condition.—Small foreign body localized "intraocularly" in the left eye, but discovered, by palpation, to be deeply embedded in the sclera temporally and 6 to 8 mm. horizontally posterior to the limbus.

After cocainization, incision through external rectus, parallel with its fibers, division of Tenon's capsule and episcleral tissues, and instrumental extraction of the foreign body with no embarrassing after-effects whatever.

Injuries of all types were witnessed, ranging from such destruction of the globe as to render the sclera actually mere

threads, to lesser tears and incisions, usually through the ciliary region, and associated with prolapse of the ciliary body. Occasionally, the anterior segment of the globe would appear normal and it would be found that a projectile entering near the orbital margin, behind the equator, had literally wiped away the sclera posteriorly, so that, after circumcising the cornea and cutting the muscles in an enucleation, one would find the globe quite deficient posteriorly.

Iris—Pupillary Changes.—If the writer were asked what most impressed him among all those medical and surgical aspects characterizing army ophthalmology, he should unhesitatingly answer "pupils." His respect for the information conveyed by this tiny iridic aperture has leaped to the pinnacles of admiration, and he is so imbued with the necessity of routinely consulting this oracle that he becomes quite exasperated when a patient is sent in from another source with his pupillary morphology and reactions indeterminable, owing to an ignorantly prescribed and previously instilled mydriatic.

With the enforcible coöperation and obedience of the patients, and the close alliance of all those departments necessary for the prompt investigation of suspicious inequalities or reactions, it has been possible to investigate rather thoroughly many apparently insignificant changes which would in civil practice have been dismissed without more ado, owing to the subject's unwillingness to be "bothered" further or to undergo discomforts, or to go into expense, or else the examiner meeting possible difficulties in the way of securing sufficiently prompt consultations.

The result of these has been to confirm, in the observer's mind, the almost invariable pathogenicity of these manifestations and to inculcate in him a resolve that he will never allow such cases, no matter how apparently trifling, to be dismissed until the utmost investigations have been satisfactorily conducted to a negative conclusion. By far the

most common type of change was this picture: very slight miosis and almost imperceptible inequality, sluggish reaction to light, or, perhaps, entire lack of such reaction. Paradoxically enough, oftentimes, one pupil would be semidilated, the other being normal or slightly miotic, and the reaction sluggish or absent in one or both or either. Usually the pupils were oval or elliptic in shape and not perfectly symmetric in their contraction or dilatation. Under mydriasis the relative inequality would persist. Very often there were no ophthalmoscopic changes determinable, and if present, usually but a temporal pallor and loss in level of disc's surface, associated with attenuation of the retinal vessels, the picture merely presaging the atrophy to come.

Occasionally, concurrent ocular manifestations, abducens palsy, or unilateral ptosis were associated.

Almost invariably the blood Wassermann would be strongly positive, the cerebrospinal fluid negative, and it was felt, after complete histories were admitted and negative neurologic tests established, that these signs occurred in a late secondary stage and well before the tertiary had set in, thus demonstrating the value of early recognition of these pupillary phenomena in the forestalling of the usually ensuing nerve degenerations and atrophies.

Another interesting type of pupillary change was observed in aged men who had led vigorous, exposed, strenuous, out-of-door lives, and in whom, although superficial pressure was not materially elevated, a deeper cerebral sclerosis was suspected. These cases presented a miosis, occasionally marked, usually equal, but sometimes more noticeable in one eye than in its fellow. There was, almost without exception, a slight or sluggish reaction to light, but this case showed, for a time, a typical Argyll-Robertson pupil:

Major General G. B. D., aged fifty-seven years. Infantry. September 3, 1918.

History.—Patient came to this eye clinic on April 2, 1918, stating that he had worn reading glasses for nine years, last changed four years ago. Subsequent to a mild "gassing" two months previously his eyes had been inflamed and secreted hyperactively, noted particularly in the morning on awakening. He further remarked that identical symptoms were present prior to each former ophthalmic examination, nine and four years ago respectively. Had used atropin internally for a long time.

At this time inspection revealed slight congestion of the superior and inferior palpebral conjunctivæ of both eyes and small pupils which reacted sluggishly to light, accommodation, and convergence, and consensually. Muscle tests demonstrated orthophoria of extraocular muscles. V.R.E., 20/30; L.E., 20/20.

Cocain mydriasis was induced by local instillations of three drops of a 4 per cent. solution, and an hour later the retinoscope revealed compound myopic astigmatism in each eye. Ophthalmoscopy showed slight pallor of the temporal half of each disc, and dark distended retinal veins.

Subsequent dynamic refraction corroborated the retinoscopy, and patient accepted the following: O.D. sph. $-.25 \bigcirc$ cyl. $-.75$ ax. $55^\circ = 10$ 15; O.S. sph. $-.37 \bigcirc$ cyl. $-.37$ ax. $135^\circ =$ 20 15. For his presbyopia a plus 2.25 sph. was added to bring his near-point to the proper distance.

The patient returned subsequently for ophthalmic consultation, as he was "under observation for organic disease of the central nervous system."

Present Condition.—Marked miosis; pupils average from 1 to 2 mm. in diameter and are horizontally oval in outline, particularly the left, which is decidedly so. There is no demonstrable reaction to light, though repeatedly and diversely tested with both natural and artificial illumination. There is a sluggish and barely perceptible reaction to accommodation and convergence. Grayish pupillary reflex. Tension normal to palpation. Ophthalmoscopy: Right eye: The temporal half of the disc is pale and the level of its surface decreased, while the overlying retinal vessels are a trifle attenuated. Left eye: In addition to the above there is a small choroidal pigment deposit in the periphery of the fundus superiorly, while about $^1/_4$ disc diameters supero-

nasal to the fovea there are two small spots of choroiditis with pigment deposits, thinning, and decolorization, with the lighter color of the sclera showing through.

Perimetry.—Negative except for slight contraction of blue field.

Conclusions.—There is a slight partial temporal atrophy of both optic papillæ, doubtless secondary to a low-grade choroidoretinitis, the choroidal evidences being grossly observable with the ophthalmoscope in the left eye. There are miotic pupils which do not react to light. The visual fields show no evidence of disturbance in the conducting elements, but the blue contraction is relative evidence of retinal changes in the absence of hysteria. The pupillary phenomena do not fit under the head of those rare congenital or post-traumatic disorders, because, as recently as last April, there was reaction to light.

The examiner does not regard the patient's long-standing use of atropin as influencing the etiology of the miosis and loss of pupillary reaction to light. It is possible that the aforementioned pupillary disturbances and the limited choroidal changes could be due to various causes other than lues, but when found together, as they are, the examiner feels that a negative blood and spinal fluid Wassermann should be assiduously sought.

N. B.—All tests were performed as advised by writer and specialists in other domains, but negative results only were achieved. The patient was then kept on a restricted light diet, at perfect ease, resting most of the time in bed.

September 7, 1918: Pupils, tested daily, have failed to show any response to light. Today a minute qualitative difference in the size is observed when regarded in alternate subdued and brilliant illumination, though the transition itself is too faint to perceive.

September 8, 1918: The same difference in size of pupils as recorded yesterday. In addition a very slight and extremely sluggish reaction is observed for the first time.

September 9, 1918: Major Derby, called in consultation, remarks: "Pupils small, slightly irregular in outline, and show slight but sluggish reaction."

The conclusion seems obvious, namely, that this was a case of *irritative miosis* from a slight cerebral arteriosclerosis

aggravated by hard work, exposure, and worry, and relieved by regular meals, rest, and freedom from care.

This history demonstrates an almost similar condition:

Mr. G. B. A., aged fifty-two years. Y. M. C. A. Secretary. August 27, 1918.

History.—First noticed that left eye turned in at one and a half years of age. Operated on at seven years, no improvement. Operated again two years later, which straightened eye. Does not remember ever having practical vision in left eye. Has been wearing glasses since twenty-one years of age. Measles at thirty-six years. F.O.H., negative.

Present Condition.—Well-nourished, florid man, considerably older in appearance than his age would indicate. Slight concomitant divergent strabismus, left eye. Pupils small and reaction to light and accommodation almost imperceptible in right and not demonstrable in left. V.R.E., 20/50, with old glasses, 20/20. V.L.E., counts fingers at three feet. Homatropin, 2 per cent.

August 28, 1918: Ophthalmoscopy: Negative. Static refraction: O.D. sph. $-1.50 \supset$ cyl. $+2.50$ ax. $90^\circ = 20/20$; O.S. sph. $-3.50 \supset$ cyl. $+7.00$ ax. $75^\circ =$ no improvement.

September 3, 1918: Add sph. $+2.25$ for near. Wassermann and urinalysis negative.

Diagnosis: Mixed astigmatism both eyes; amblyopia exanopsia, left eye; *irritative miosis*, both eyes.

Others observed were evidently of congenital origin:

Hospital Sergeant W. C. W., aged thirty-two years. Medical Department. December 15, 1917.

History.—Since a fall upon occiput in childhood, at which time he was not severely hurt, patient has had immobile pupils and absence of knee-jerks. Sent in by his commanding officer because of the abnormal pupils. No present ocular complaint and personal and family ocular and medical histories negative.

Present Condition.—Pupils vertically oval, the left somewhat smaller than the right, and both are immobile to all tests. V.R.E., 20/20; L.E., 20/80. Cycloplegic.

December 18, 1917: Pupils well dilated. Ophthalmoscopy:

Both eyes: Deep central physiologic excavations. Simple refraction error found, correction of which brought vision to the normal point. Blood and spinal fluid Wassermann negative. Also all other consultation reports.

Private H. W. C., aged twenty-one years. Infantry. September 6, 1918.

History.—Vision of left eye has been poor as far back as he can remember. Three months ago was struck in the left eye with a stick, vision gradually diminishing about one month later. At present can only distinguish light from darkness. Dull occipital headache periodically. Wore glasses at twelve years of age, but for short time only. All members of family wear glasses. V.R.E., 20/20; L.E., 1/80.

Present Condition.—There is marked corectopia of the left eye, the pupil being situated temporally and with its outer edge about 3 mm. from the limbus. It is perfectly circular in outline, and with its fellow reacts normally to all stimuli. The superior and inferior palpebral conjunctivæ are slightly congested.

Muscles: ½° esophoria and 2.5° left hyperphoria at 20 feet; 4° exophoria at 13 inches. Homatropin, 2 per cent.

Ophthalmoscopy: O.D., negative save for the presence of a small, anomalous, cilioretinal vessel, which leaves the disc near its inferotemporal margin. O.S., pupil dilates equally in all directions, the temporal margin being practically in the temporal angle of anterior chamber. Inferonasal to the disc there is a definite conus, delimited by a crescent-shaped pigment line, between which and the disc itself is clearly visible the exposed choriocapillaris with the intercapillary islands of stromal pigment practically absorbed and the underlying sclera showing through. In the extreme temporal portion of the fundus are two buff-white colored spots of probable old, absorbed choroidal exudates. In the foveal region there are considerable congestion and diffuse, granular pigment deposits, all about one-half disc diameters in size. Retinoscopy: O.D. sph.+1.50; O.S. sph.+.25⊂cyl.+1.50 ax. 120°.

Diagnosis: Compound hyperopic astigmatism, right eye; mixed astigmatism, left eye; corectopia, left eye; chorioretinitis, old, left eye.

A few illustrations picked at random will follow, but the majority of the pupillary changes occurred in conjunction with other ocular states, so that they will be found elsewhere in this paper, beneath different captions.

First Lieutenant E. J. McC., aged thirty-five years. Medical Corps. Ambulance Company. December 18, 1917.

History.—About three weeks ago had a catarrhal conjunctivitis in the right eye which cleared up in about five days. Awoke this morning with cilia matted together by dried mucopurulent secretion, while the eye and lids burn and itch. Upon recognizing patient's face the admission is wrung from him that he is the individual who appeared informally at the hospital one Sunday morning when the regular clinic was closed, to ask whether his pupils reacted and were normal, at which time the writer found Argyll-Robertson pupils, pale atrophic papillæ, and a positive Wassermann, the patient promising to return in a day or two in order that he might be entered upon the outpatient department books and that he might hear the result of his blood test. He seems to have no excuse for his apparent lack of interest and failure to return.

Present Condition.—Acute catarrhal conjunctivitis, smear negative microscopically. Pupils unequal and react somewhat sluggishly to accommodation, but remain fixed to light. Patient refuses to enter the hospital or have any treatment for his constitutional malady, but desires only a collyrium for his conjunctivitis. He will not consent to neurologic or other consultations.

N. B.—As this man was a physician, and in a rather responsible position, the writer reasoned and argued with him and took great pains to put the case before him in as intelligible a manner as possible, having all due regard to the eventualities, such as dementia, paresis, and tabes, and begged him to reconsider his determination to do without treatment. The patient here showed his greatest instability of mind and vacillation, because he repeatedly decided to enter the hospital and have a thorough examination and would almost immediately change his mind, going so far as actually to enter the hospital and have his ward bed assigned to him and then quietly packing up and leaving. It was most

aggravating, and had it happened later, could have been settled whether the patient willed it or not, but fresh from civil life, too much consideration was shown the subject as a physician. The examiner and the neurologist who were waiting to examine the patient were convinced, from the patient's behavior at the time, that he was an early case of general paresis.

Diagnosis: Argyll-Robertson pupils; unequal pupils; positive blood Wassermann; partial primary optic nerve atrophy; probably early general paresis.

Captain O. F. G., aged forty-seven years. Infantry. May 4, 1918.

History.—For the past ten days eyes have been inflamed, burned, and itched. About three years ago had the same symptoms, which soon passed away without treatment. Had chancre at age of twenty years, and malaria in 1917. Is a painter by trade; served six months on the Mexican border, and is a very moderate user of alcohol. Family ocular and medical histories negative.

Present Condition.—Lid margins congested and thickened, cilia sparse, superior and inferior palpebral conjunctiva hyperemic. The pupils are unequal, the right being semidilated and the left miotic. The former does not react to light, the latter but sluggishly. There is general glandular enlargement and the signs of an old scar on the surface of the glans penis.

V.R.E., 20 40; L.E., 20 20. Homatropin, 2 per cent. Advise Wassermann.

Retinoscopy: O.D. sph.+1.00⊃cyl.+.50 ax. 105°; O.S. sph.+1.00. Static refraction: O.D. sph.+1.00⊃cyl.+.25 ax. 120°=20 30; O.S. sph.+1.00=20 30−. Wassermann report: positive, 100 per cent.

Advised neurologic consultation, as the history and the pupil changes suggest possible general paresis.

May 12, 1918: Neurologic Report: No objective evidence of deterioration. Pupils: Left is small and reacts to light and accommodation. The right is wide, round, regular, and without light reaction; accommodation reaction sluggish. There is a slight tremor of the tongue and lips, also of the hands. All deep reflexes are overactive, the right equaling the left.

There is a very slight ataxia of the hands (questionable). No gait disturbances. Speech rather slow and somewhat slurring. Mental state: No sign of deterioration in any field.

Diagnosis: General paresis, early stage.

The following is a brief abstract from the report of the case of Sergeant J. F. R.:

Patient has elaborately systematized ideas of persecution, thinking that he is pursued by the influences of enemies at home who continue to balk all his efforts. Denies lues.

Well nourished and developed. Anisocoria, left pupil larger than right. Light reaction present but sluggish. Brownish scars over shins and some roughness of tibia. Lips and tongue quite tremulous, no marked speech defect. Moderate general glandular enlargement. Heart and lungs negative. Old scar on glans penis. Reflexes: No defect in gait or station. No ataxia. Blood Wassermann positive, 100 per cent. Patient refuses lumbar puncture.

Diagnosis: Lues of the central nervous system; general paresis, early.

Unfortunately, no Wassermann report was returned on this case, though he admitted luetic history.

Private L. R. M., aged twenty-four years. Infantry. July 1, 1918.

History.—First noticed that distant vision was poor two years ago. Never wore glasses. At present everything seems blurred, both in distance and in near. Cannot read any kind of small print. Childhood diseases. "Venereal diseases" two years ago. Mother and brother wear glasses.

Present Condition.—Pupils do not react to light. Inferior conjunctivæ slightly congested. Patient thinks he has had a slight attack of gonorrheal arthritis, left hip. V.R.E., 8/200; L.E., 5/200. Atropin, 1 per cent.

July 3, 1918: Ophthalmoscopy: O.D., all details blurred, a few small glistening spots in macular region, round spots of choroidal atrophy with exposure of sclera and pigment changes in the periphery. O.S., choroidal changes more marked but not the macular. Static refraction: O.D. sph.

+1.00 ⊂ cyl.+.25 ax. 90° = no improvement; O.S. sph.+1.00 ⊂ cyl.+.25 ax. 90° = no improvement.

Diagnosis: Compound hyperopic astigmatism; old choroiditis and secondary retinal and optic nerve atrophy, both eyes.

July 23, 1918: With glasses: V.R.E., 12/200; L.E., 19/200. August 17, 1918: V.R.E., 20/70; L.E., 20/100. August 24, 1918: V.R.E., 20/100; L.E., 20/70. Dynamic refraction: Less sph. −.50 = 20/50.

Private S. W. T., aged twenty years. Field hospital attendant. August 23, 1918.

History.—While reading, about a month ago, right eye suddenly became "blurry." Noticed right pupil larger than left shortly after blurring. No venereal history. Childhood diseases. Has been having severe attacks of diarrhea.

Present Condition.—Slight conjunctival congestion, right eye. Ophthalmoscopy: Negative. Right pupil does not react to light or convergence. No other evidence of third nerve paresis. Is having teeth treated. Nasal examination negative. If Wassermann should be negative, advise that he continue treatment with potassium iodid. If Wassermann positive, treat accordingly. Dynamic refraction: sph.+1.00, each eye. No glasses prescribed. Wassermann report: Positive.

Of course, there have been many other pupillary abnormalities noted in connection with blinding, diseases, and injuries, but they will be considered under other headings.

In considering affections of the iris more especially observed in warfare, that purely traumatic type of iritis so often met with can best be described by detailing an unusually characteristic case:

Private R. D. D., aged nineteen years. Infantry. February 5, 1918.

History.—Yesterday morning a companion's rifle, loaded with two grenades, exploded and the patient was struck on the lateral aspect of the left brow with a fragment. The eye was bruised and soon swelled shut, but the fragment, still protruding from the wound, was removed. The patient

could not see with the left eye, even when the swollen lids were lifted, and stated it had always been weaker than the right.

Present Condition.—There is a slight abrasion above the left eyebrow, with some accompanying edema of the tissues and ecchymosis of the lid. The conjunctiva of the left eye exudes a mucopurulent secretion and is acutely inflamed. The iris is rather mud-colored, the cornea a trifle dull, and the pupil unequally dilated by the atropin, owing to the strongly organized posterior synechiæ of a typical iritis. The right eye is normal in appearance. V.R.E., 20/50; L.E., 18/200. Ophthalmoscopy: Right eye: Negative. Left eye: Hazy media and great blurring of fundus details. Advised *x*-ray, medical, and specialties consultation.

February 20, 1918: Roentgen report: A small foreign body in left orbit. After a thorough local and constitutional regimen: V.L.E., 20/50. Ophthalmoscopy: Left eye: Media clearer than before, and fundus details more easily studied nothing remarkable noted.

March 1, 1918: Despite atropin cycloplegia the vision of the right eye is 20/30; of the left, 20/70. Ophthalmoscopy: Left eye: Slight residual vitreous haze, otherwise negative. Results of dental, laryngologic, medical, and laboratory consultations negative.

March 8, 1918: Examination of left eye shows it to be in a practically normal state. Ophthalmoscopy is negative, except for a delicate veiling of details. Static refraction: O.D. sph.+.50 ⊃ cyl.+.25 ax. 180° = 20/30; O.S. sph.+.50 ⊃ cyl. +1.25 ax. 150° = 20/30.

Diagnosis: Foreign body, left orbit; iritis, traumatic, seroplastic, left.

As seen in military practice, iritis, aside from the traumatic variety of kerato-iritis mentioned above, has been inordinately severe in type, and in its acute non-specific form has been characterized by hyphema and tremendous vascular reaction, conjunctival and ciliary turgidity, ecchymosis, etc. It has been possible, in a number of cases, in contradistinction to those low-grade types complicated with uveitis, to discover an etiologic factor in many instances, and here again

dental foci have been the preponderating causes, sinusitis and other factors being less frequently observed.

Many cases of acute seroplastic iritis have entered the hospital within a week of the inception of the infection in a practically blind state, so explosive have been these attacks. This may have been due to the out-of-door life, the exposure to the damp, and the lack of heat, all tending to favor the lowered resistance of the exposed eye and the rapid spread of an infection in the iris. Foreign bodies in the iris, in the form of powder granules (*vide supra*), were not uncommon. Otherwise heavier pieces, such as copper and steel, of exploding grenades, or detritus scattered by bursting shells, struck with such force that they usually penetrated deeper, their rents of entrance often being detectable in the iris stroma, if not chancing to be masked by a small local blood-clot. Occasionally a true iridocyclitis was observed after severe blows upon the eye, with or without dissolution of the continuity of the ocular tunics. The case here quoted was struck over the closed lids with a particle of projectile which did not penetrate, but which, by commotion, produced the iridocyclitis and localized lenticular opacity. Very occasionally the sphincter pupillæ would be ruptured, and still more occasionally the iris, partially or totally displaced from the force of impact, was observed entirely retroverted.

Good examples of average injuries involving the iris are the following:

E. P., aged fifteen years. Errand boy in military foundry, Vaucoulers. January 22, 1918.

History.—Patient was brought to the hospital a month ago with a perforating wound of the right eye caused by an exploding hand grenade. The wound was near the limbus inferiorly and the iris was prolapsed. This was immediately drawn out and excised; a sterile magnet tip was inserted but failed to demonstrate the presence of a magnetizable foreign body. The pillars of the coloboma were replaced, and a conjunctival flap brought over the sclerocorneal wound

with perfect surgical results. When sufficiently healed, patient was told to report to the dispensary for ophthalmoscopic, visual, and refraction tests.

Present Condition.—Patient under effect of previously instilled atropin. In the right eye there is a large, inferiorly situated coloboma with free pillars and no bulging of the overlying cicatrix. Ophthalmoscopy: Negative. Static refraction: O.D. sph. $-1.50 \bigcirc$ cyl. -1.00 ax. $135^\circ = 20/30$. O.S. sph. $-.25 \bigcirc$ cyl. $-.75$ ax. $75^\circ = 20/20$.

Private C. H. K., aged thirty-two years. Infantry. May 23, 1918.

History.—About six months ago a nail struck him in the right eye. About nine years ago he was hit on the right eye with a baseball. Has just had two iridectomies performed by the writer for incarceration of the iris of the right eye in the cicatrix beneath the temporal limbus. The anterior synechiæ were divided and the pupil has assumed a more central position. Prior to operation vision was 20/70 plus.

Rheumatic fever in 1903. Pleurisy in 1915. Black diphtheria in childhood. F.O.H. Negative. Ophthalmoscopy: There is some local striate keratitis at and about the site of operation; the temporal margin of the pupil is somewhat ragged, and there are a few equatorial lenticular striæ and vacuoles. V.R.E., 20/70 plus; L.E., 20/30. Atropin, 1 per cent.

May 27, 1918: Static refraction: O.D. sph. $+.25 \bigcirc$ cyl. -1.25 ax. $15^\circ = 20/30$. O.S. sph. $+.50 \bigcirc$ cyl. $+1.00$ ax. $165^\circ = 20/20$.

Diagnosis: O.D., mixed astigmatism; O.S., compound hyperopic astigmatism.

October 10, 1918: V.R.E., 20/40; L.E., 20/40, without glasses. V.R.E., 20/40; L.E., 20/20, with glasses.

Ophthalmoscopy: Lenticular vacuoles have almost cleared up, also the corneal opacities. The pupil is as last described. Advised reclassification, Class A.

Ciliary Body.—An apparently idiopathic uveitis gave considerable trouble to the writer, and those with him, because it was so resistant to treatment and tended after apparent cure to relapse, some cases being affected almost continuously

for months, during which the vision was very poor. All studies which one could make in an army base hospital were unavailing and the writer remains nonplussed. A few of the more persistent and deeper seated cases of scleritis showed ultimate evidences of a low-grade serous cyclitis.

Cyclitis and iridocyclitis almost invariably followed wounds in or near the region of the ciliary body or cases with intraocular foreign bodies. These varied between the rather rapid, infected cases with a puro-plastic panophthalmitis, and the far more frequent, slowly and inexorably progressive, proliferating uveitis, and necessitated much more careful watching. Almost invariably enucleation became imperative in order to obviate the serious sympathetic changes. Injuries of the ciliary body have been quite common and great prolapses were not infrequently seen. The prognosis in general was very poor, but excision and covering with a large conjunctival flap occasionally quieted the condition, at least so long as the patients were under observation in the author's clinic. Small bodies traversing the ciliary body through and through without causing prolapse did not produce those plastic changes noted above, and if removable from the eye, or if lodged beyond the globe in the orbit, or even in the posterior sclerotic, good results were expected.

No cases of sympathetic inflammation ever occurred in this eye center, or, in so far as the writer can determine, in any of the clinics of our entire army. Colonel Lister, of the British army, tells me that they have had no case, and it is known that they have been quite rare in the French and German armies. Those which have occurred were followed up very closely, especially by Müller, and the conclusions drawn tend to refute, curiously enough, the hypothesis of Elschnig, emanating from Prague some years ago, and carry one back to the old-fashioned infection theory.

The author has had three cases of frank, outspoken sympathetic irritation due to hyperconservatism and the desire

to save the primarily injured globe if possible. These all showed, one to three weeks after injury, slight ciliary congestion, blepharospasm, excessive lacrimation, and hyperemia of the papilla, with blurring of its margins in the unaffected eye, the patient experiencing at the same time in that eye such annoying subjective symptoms as photophobia, slight, sharp, pricking pains in the globe, and alternating phases of blurred and clear vision.

Private J. A. G., aged twenty-one years. Infantry. February 23, 1918.

History.—At 4.30 A. M., January 24th, patient looked over the top of the trench and received a piece of an exploding grenade in the left eye. Ten minutes later the first-aid man put iodin over the cut in the lid. He suffered great pain and was taken to the infirmary at 7 P. M., thence to Field Hospital No. 13, where he was anesthetized, his injured eye thoroughly examined, and no wound of the globe found, the cut in the lids being the only discoverable lesion. He was retained here for two days and then sent to Field Hospital No. 12, where he was kept in bed with cold compresses for five days, during which he suffered considerable pain. For the first five or six days, he insists, he was blind in the right eye. A dressing was put over his eye and he was kept in bed for an additional five days and then allowed to be up and about until he was evacuated to this hospital today, one month after the receipt of the injury.

Present Condition.—Wound, multiple, involving both lids and the globe of the left eye. The eyeball is semi-phthisical, soft, its tunics congested, the iris mud-colored, with its stromal texture obliterated and retracted by posterior-lying cyclitic membrane; the anterior chamber deep, and the pupillary space filled with a densely organized exudate through which but a faint fundus reflex is obtainable with the ophthalmoscope. The right eye manifests marked blepharospasm, lacrimation, and photophobia, with hyperemia of the conjunctival and ciliary vessels, while the ophthalmoscope shows dark, distended retinal veins and hyperemic papilla. V.R.E., 20/30−; L.E., blind. X-ray advised and showed a foreign body in the left orbit. Because

of the hopeless condition of the left eye and the sympathetic irritation in the right, enucleation was performed, and a large piece of grenade removed from the supranasal lip of the orbital edge of the optic canal.

Diagnosis: Uveitis, proliferating, traumatic, left eye; irritation, sympathetic, right eye; foreign body, orbit, left eye.

Upon performing complete enucleation of the exciting eye the sympathizing eye at once regained the normal.

Choroid.—Doubtless, because of the previous physical examinations and the "weeding out" of most of the grossly defective eyes, very few of those extensive choroiditic changes were witnessed. But it was not uncommon to see early luetic diffuse choroiditis and occasionally the incipient disseminated exudations, syphilis being at times primarily suspected in just such instances, the men having come in, usually for simple refraction tests, and the beginning lesions were detected in the course of the routine ophthalmoscopy during mydriasis. Traumatic choroiditis was now and then observed, but choroidal rupture was far commoner, and most beautiful examples of this contre-coup lesion were rather frequently seen. Wounds in the region of the orbit, and not touching the ball, usually produced large choroidal hemorrhages, the waves of force radiating through the bony structures and being transmitted to the globe.

Panophthalmitis often occurred, but owing to the rapid disintegration of the vitreous, precluded ophthalmoscopic studies. However, the examiner has seen perforating wounds of the sclera, far back and involving the choroid, which prolapsed or showed ophthalmoscopic changes not differing from those associated with industrial accidents. These, as a rule, did well.

Phthisis bulbi was not very frequently observed, because enucleation was usually necessitated prior to any considerable degree of atrophy.

A few times the examiner has seen cases, usually officers, who had been humored by their oculists and allowed to retain the wounded eye despite the presence of non-removable intraocular foreign bodies. Although only a month to six weeks' standing, considerable phthisis bulbi was present, the iris atrophic, the lens cataractous, the retina detached, and the eye blind. One malingering officer who desired to remain in the army (*vide infra*) successfully duped many into giving him a record of normal vision in his blind, semiphthisical eye.

Crystalline Lens.—Partial cataracts were occasionally seen following severe concussion, non-penetrating blows over the globe, or wounds of the bones of the face and of the orbit. These usually remained stationary. True traumatic cataract was rather common; a small foreign body penetrating the cornea and passing through or lodging in the substance of the lens, thus cutting its capsule and allowing the aqueous to enter and opacify the crystalline. Often the foreign bodies—powder granules, pieces of sand, stone, or metal—could be seen or radiographically localized in the lens, such cases being quite easy of removal. Occasionally the soft, sticky, spongy lens matter would become agglutinated to the corneal scar, or separate and prevent the apposition of the lips of the incision. Usually good results were obtained by linear extraction, irrigation, or spooning if needed, and subsequent needling or capsulotomy. Suction devices were never employed in this clinic.

It was not uncommon to see dislocated lenses and to recognize them by the iridodonesis, unequal depth of the anterior chamber, and varying vision, the patients in one or two instances having monocular diplopia. Subluxation was the type oftenest met.

Vitreous Humor.—The hyaline body suffered from hemorrhages, infections, and the presence of foreign bodies. Aside from the usual conditions seen in civil practice, nothing re-

markable was noted. In these young men vitreous hemorrhages, as a rule, cleared up with startling rapidity. Usually some form of proliferating retinitis or hyalitis, occurred as a sequel. Here ensues a history of that type of case one meets at home:

Sergeant A. C., aged twenty-two years. Machine Gun Battalion. December 18, 1917.

History.—Sent in from military hospital in neighboring village. On December 12th patient noticed dark spots dancing before right eye. By night he was unable to distinguish objects with that eye clearly enough to tell them by name. When attempting to read or write, patient's eyes water and incapacitate him for work generally. There has been no improvement in the condition. No history of any injury or previous trouble with the eyes. Had measles, whooping-cough, and scarlet fever at ten years of age. The next day he went to a French hospital, where his case was diagnosed "hemorrhage into the vitreous." Last May he was struck over the forehead with the handle of a pitchfork, at which time his eyes became "black and blue." Has lost a little weight lately, but thinks it due to excessive exercise. His general health is good. His mother had weak eyes.

Present Condition.—External examination of the eyes negative. V.R.E., hand movements; L.E., 20 20. Impossible to obtain fundus reflex in right eye with the ophthalmoscope. Atropin, hot compresses, potassium iodid. Advised Wassermann, urinalysis, blood-pressure determination, and general as well as special consultation, all of which were negative, though the blood-pressure was 130 85.

The patient was regarded as having one of those obscure types of vitreous hemorrhage occurring spontaneously and often associated with a strumous or definitely tuberculous diathesis, but it was impracticable to follow up the studies and he was empirically treated as such and kept until January 10, 1916, before evacuation, on which occasion his vision had improved through the "counting finger" stage to 12 200. With the ophthalmoscope the fundus reflex was clear, bright, and many fine, thread-like, and diffuse granular vitreous opacities were observed. These were in sufficient numbers to render the details of the fundus blurred.

Diagnosis: Hemorrhage, idiopathic, vitreous, right eye.

Private J. P. G., aged nineteen years. Infantry. June 24, 1918.

History.—Wore glasses constantly for ten years until two years ago. Has a sharp, shooting pain in eyes, accompanied by "dizzy spells." Subject to headache. When reading, print blurs and runs together. Vision of left eye seems to be worse than right. Eyes water excessively. Lids stick together in the mornings. Sees black spots before eyes after concentrating on objects. Is aware of diplopia at times. "Gassed" June 17th. Was struck on head, over right eye, with ball seven years ago, and has noticed that distant vision has been poor since then. "Scarlet fever" three years ago. Childhood diseases. Mother has weak eyes. Is having trouble in breathing since being gassed.

Present Condition.—Left eye does not converge with right. Insufficiency of internal recti. R.E., 20/100; L.E., 20/200. Atropin, 1 per cent.

June 26, 1918: Ophthalmoscopy: Right eye, negative. Left eye, floating vitreous opacities, partially organized papillitis, with secondary atrophy of disc and obscuration of vessels. Large spots of choroidal and retinal atrophy, possibly site of former hemorrhages. Retinitis proliferans with strings of organized exudate or hemorrhage extending forward into vitreous. Static refraction: O.D. sph.+1.75⊃ cyl.+1.25 ax. 90°=20/20. O.S. sph.+1.25⊃cyl.+2.25 ax. 75°= No improvement. Advised Wassermann and urinalysis. Not reported upon.

Wagoner J. H. W., aged twenty-six years. Supply Company, Infantry. February 23, 1918.

History.—Patient complains of loss of sight in left eye, accompanied by an aching pain in the head. This began about two months ago following a blow with a large branch of a bush. About ten or fifteen days later the vision of the left eye was practically gone, the patient being able to distinguish merely light from shadow. He gives a definite history of secondary lues in July, 1917, for which he was treated in the St. Nazaire Hospital.

Present Condition.—External ocular examination negative. V.R.E., 20/50; L.E., L.P. Mydriatic instilled.

Ophthalmoscopy: Right eye: There is a retinitis pro-

liferans and a large white mass of scar tissue juts forward, fungus-like, from the papilla into the vitreous. There are a few string-like, floating vitreous opacities. Left eye: There are large masses of partially absorbed exudate or old hemorrhage floating about in the fluid vitreous; a dense, flat, white retinal scar is present in the foveal region, surrounding a centrally placed, garnet-red, spheric sector, the fovea centralis. Wassermann requested.

February 24, 1918: Wassermann test, which had been negative for a long time, again negative.

March 1, 1918: Again advised Wassermann.

March 2, 1918: Wassermann blood test, 25 per cent. fixation.

Diagnosis: Hyalitis, old, bilateral; retinitis proliferans, right; choroidoretinitis, left; tertiary lues.

It seldom was possible to see the foreign bodies ophthalmoscopically, because of associated disturbances in the other media, but this was occasionally done and one of the oculists assisting the writer removed a small, glistening, aluminum foreign body in the vitreous through a posterior sclerotomy, watching and guiding his forceps with the aid of the ophthalmoscope.

Retina.—The most interesting retinal changes met with, at least from a medical point of view, were the not infrequently occurring central retinitides following in the wake of the scarlet fever epidemic during the 1917–18 winter.

Many cases would come in for refraction tests complaining of headaches and other vague asthenopic symptoms, in which one or more glistening spots of juxtafoveal exudation were ophthalmoscopically observed in the course of the routine examination. While these would, in the greater number of cases, have negative urine, nevertheless a definite though usually mild nephritis was found in such a number as warranted the assumption that the others also represented the retinal changes in a former albuminuria now so nearly well as to give a negative urinalysis. The writer concludes

that a transitory nephritis with retinal evidence is commoner after scarlet fever than has hitherto been thought, cases, as a rule, not being followed very thoroughly for any length of time after recovery from their fever.

These types of albuminuric retinitis are very mild, rather transitory, decidedly atypical, and multiform, and are chiefly characterized by the lack of hemorrhages or the signs of pre-existing ones. The following history is quite typical:

Private G.V.D., aged twenty-one years. Infantry. March 20, 1918.

History.—Since February 1st patient has been annoyed with frequently occurring attacks of blurred vision, which last for fifteen minutes or so and have been of progressively shorter intervals and longer duration. He is also bothered with frontal headaches and pain in the eyes. Has worn glasses off and on for seven years, constantly for the past few months. Following an attack of scarlet fever in December, 1917, "eyes became swollen and infected," since then vision has been poor. Complains of dull, throbbing, frontal headaches and occasional pains in the right eye. Has been shooting poorly on the range and was ordered to the hospital for refraction. The right eye smarts and both eyes are sometimes glued shut in the morning. Had measles in March, 1917, mumps in December, 1917, scarlet fever in the same month, smallpox in 1916, and chicken-pox and whooping-cough in childhood. In 1914 had an attack of "nervous paralysis" lasting two weeks, during which power of speech was lost and he was unable to move from the waist down. Has not noticed any dyspnea or edema of the ankles or other parts. Family ocular history negative, save that mother wears glasses.

Present Condition.—External examination of the eyes negative. There is slight cervical adenitis. V.R.E., 20/70, corrected by his glasses to 20/70++. V.L.E., 20/30−, corrected to 20/20−−.

March 31, 1918: Under atropin cycloplegia: Ophthalmoscopy: Both eyes: Minute, glistening, discrete, punctate, white spots in macular region, more pronounced in the left than right eye. Static refraction: O.D. sph.+.75⊃cyl.+

1.00 ax. 90° = 20/30 − −; O.S. sph. + .75 ⊂ cyl. + 1.00 ax. 75° = 20/20 − −.

Advised urinalysis and blood-pressure determination with a view to unearthing a possible post-scarlatinal nephritis.

April 1, 1918: Blood-pressure, 140/80. Urinalysis: Yellow, cloudy, acid, albumin, sp. gr. 1015, few white blood-corpuscles, granular and hyaline casts and epithelial cells, crystals, and amorphous deposits.

April 6, 1918: Phenolphthalein excretion: First hour, 35 per cent.; second hour, 10 per cent.

April 8, 1918: Intake, twenty-four hours: 1; output, twenty-four hours, 7 A. M. to 7 P. M., 665 c.c., 1013; 7 P. M. to 7 A. M., 525 c.c., 1013. Trace of albumin, granular casts, and cylindroids.

Diagnosis: Albuminuric retinitis; nephritis, chronic, diffuse, interstitial, post-scarlatinal.

This case is one of those who may have had such a mild albuminuric retinitis following his scarlet fever in 1905:

Private H. V. M., aged twenty-seven years. Photo. Detach. Observ. Group. May 14, 1918.

History.—Wore glasses for reading for about six months. Is doing photographic work, and after being in dark-room and also after reading, has a sharp drawing pain in nasal corner of each eye, which is relieved by looking at sky. Print blurs after excessive use of eyes. Constant, dull, vague, frontal headaches and excessive photophobia. Scarlet fever in 1905. Childhood diseases. All of family have weak eyes. V.R.E., 20/30; L.E., 20/30. Atropin, 1 per cent.

May 16, 1918: Ophthalmoscopy: Superior to macula, in apposition to a small arterial twig, is a tiny yellowish-white spot which does not resemble a retinal exudate, but appears to be the site of a small former deposit. Urine: negative. Static refraction: O.D. sph. + 1.00 = 20/20 − −; O.S. sph. + 1.25 = 20/20 −.

Although diabetic retinitis was not encountered, probably owing to the fact that it is commonly a late manifestation and the condition was only seen in its early stage in army work, the following atypical case may be of interest:

Private N. J. McN., aged twenty-one years. Infantry. September 12, 1918.

History.—Vision of left eye has always been worse than right. For last two months has noticed "cob-web" in front of left eye. Wore glasses for near work last five years. "Gassed" and "shell-shocked" August 20th. Measles at five years. Pneumonia six years ago. F.O.H. Negative.

Present Condition.—Left pupil larger than right, but both react to light normally. V.R.E., 20/30; L.E., 18/200. Atropin, 1 per cent.

September 19, 1918. Ophthalmoscopy: O.D. Disc hyperemic, margins and details blurred and definite nasal edema present. O.S. Fundus details unobtainable owing to dense vitreous opacities, both granular and string-like, which swirl about with every movement of globe. Urinalysis showed a trace of sugar. Wassermann negative.

Of passing interest were the patients with pigmentary degeneration of the retina who had slipped by the examining boards and were admitted to the army. When backed up by other grave fundus changes they augur for the insertion of an ophthalmoscopic examination in the routine physical testing of recruits.

Private A. I. F. Z., aged twenty-two years. Infantry. July 13, 1918.

History.—Patient says he cannot distinguish objects at night, but can see during the day, or on moonlight nights. Has had this trouble as far back as he can remember. Glass blower for the last five years. F.O.H. Negative. Right ear is discharging at present.

Present Condition.—Inferior and superior palpebral conjunctivæ congested. V.R.E., 20/30+; L.E., 20/30−. Atropin, 1 per cent.

July 18, 1918: Static refraction: O.D. sph.+1.00⊃cyl.+1.50 ax. 90° = 20/30++; O.S. sph.+1.00⊃cyl.+1.50 ax. 90° = 20/30+++.

Advised discharge from army. Wassermann: Negative.

Diagnosis: Pigmentary degeneration of retina.

These occurred in practically the same proportion that one discovers in the ordinary civilian eye work.

The appearance of the retinal vessels has been the subject of much discussion by internists and oculists alike for several years, and while the writer has added nothing new to the knowledge gained upon that subject, yet he has substantiated much of it by his routine studies and has been gratified by both clinical and laboratory confirmation of the previously suggested, ophthalmoscopically made diagnoses in a high percentage of cases.

The typical arteriosclerotic and luetic pictures were often observed, even in these relatively young subjects.

In this case the blended syphilitic and arteriosclerotic signs were present:

Private B. F., aged thirty-four years. Medical Department. April 11, 1918.

History.—Patient complains of excessive photophobia and a sensation of a foreign body in the left eye whenever it is exposed to light. Since an accident in 1913 the left eye has weakened. About fifteen years ago he was totally blind for twenty-four hours, he thinks "probably from alkali water," with which he had washed. The examiner thinks it more likely due to bad whisky, the patient being known to him as a dipsomaniac. V.R.E., 20/20; L.E., 20/20. Atropin, 1 per cent.

April 13, 1918: Ophthalmoscopy: Both eyes: The retinal arteries are pale and pinkish in hue, attenuated, accompanied by glistening, whitish, opalescent lines, probably typifying infiltration of the perivascular lymph-sheaths. The mural transparency of the arteries is greatly diminished, and the picture is one of retinal arteriosclerosis, the opalescent, glistening character of the lines betokening a luetic foundation.

Retinoscopy and static refraction tests demonstrate an almost negligible amount of compound hyperopic astigmatism. Wassermann advised and later returned 100 per cent. positive.

One can see the characteristic luetic picture in the subsequent case:

Private E. W., aged twenty years. Medical Department. March 1, 1918.

History.—Patient complains of partial loss of vision in the left eye of six months' duration and both eyes seem weak; that the right eye has turned upward for the past five years, progressively more so for the past six months; for five months the audition of the left ear has been defective. Diplopia is present, but not particularly annoying. He knows of no possible cause for these troubles. Wore glasses for three years—until last December. Denies syphilis, but admits having had gonorrhea six months ago, and measles and mumps in childhood. One sister died from an unknown cause; his mother died at sixty years from a "stroke." His father had cataract and his mother's eyes were always weak.

Present Condition.—External ocular examination negative except for right paralytic sursumvergent strabismus, the globe being deviated upward with its vertical axis twisted nasally in the direction of 105 degrees. The diplopia field, mapped in the conventional way, shows variations quite definitely characteristic of an isolated paralysis of the right inferior rectus muscle. V.R.E., 20/30; L.E., 18/200. Because of the above visual record the right eye, despite its paralysis, was employed as the fixing eye and an appropriate head posture was assumed.

March 3, 1918: Under atropin cycloplegia. Ophthalmoscopy: Both eyes: The retinal arteries are pale, pinkish, and with opalescent, creamy, glistening, greasy-looking lines of perivascular infiltration, which the examiner has yearly grown to regard as more and more definitely suggestive of lues. Static refraction: O.D. sph.+.75⊃cyl.+.50 ax. 75° = 20/20−; O.S. sph.−.50⊃cyl.+3.25 ax. .90° = 20/40 plus. The result of the refraction tests shows the poor vision to be principally due to the functional difficulty in compensating for the mixed astigmatism and not due to any organic cause. Aural consultation negative for local disorder. Neurologic examination: Paresis of left third nerve, relative deafness in both ears, left greater than right. Lues, congenital.

March 5, 1918: Lumbar puncture: globulin, negative. Cell count, 25 per c.c.

Wassermann, 100 per cent. Fixation.

Diagnosis: Paralysis inferior rectus muscle; cerebrospinal lues.

Another interesting type is shown by Private J. T. C., quoted under optic conditions. The essential arteriosclerotic fundus is described in the case of Private H. S. B., quoted in full under the subject of muscle paralyses.

An interesting flat detachment of the retina which later practically completely recovered probably occurred as the result of a necrotic tooth and is here briefly quoted:

Private D. S. T., aged thirty-one years. Field Artillery. August 29, 1918.

History.—Eye-sight failing last three weeks. No previous trouble with eyes. Slight headaches. Otherwise well; one bad tooth.

Present Condition.—Slight conjunctival congestion. V.R.E., 20 40−; L.E., 17 200. Pupils react rather sluggishly. Single drop of 2 per cent. homatropin; pupils dilated regularly and equally. No descemetitis seen. Ophthalmoscopy: O.D., vitreous clear. Slight engorgement of vessels, numerous fine glistening dots in region of macula, otherwise normal. O.S., no deposits on lens or cornea; very numerous dust-like vitreous opacities, some slightly larger. Disc a trifle blurred. Central retina somewhat thickened and vessels dilated. Grayish line extending down and in from above macula, evidently beginning choroiditis. Vessels in inferotemporal position very dark and slightly elevated, indicating a flat detachment of retina secondary to the acute choroiditis. Gives history of blow over left eye eighteen months ago, not followed by any particular visual disturbance.

Nasal examination, negative. Wassermann, negative. Dentist reports necrosis and impaction of molar; *x*-ray shows area of necrosis about root of same.

Injuries of the retina were as varied as they were numerous. Much has been written of these, Lagrange having covered the

ground more thoroughly perhaps than other contemporary observers. The direct injuries were not capable of much study, owing to the destruction of parts and relations and to the impairment in transparency of the media, but the indirect mishaps to this tunic were of exceeding interest.

Slight non-penetrating bulbar blows often produced commotion, detachment, rupture, hemorrhage, and the like, the prognosis being rather favorable, but the fascinating changes seemed to occur in the orbital or facial injuries, the bony framework transmitting the shock waves, as when a pebble is thrown into the water. Thus innumerable cases where the globe was untouched showed every variety and degree of traumatic lesion.

As instancing these, the following histories should prove interesting:

First Lieutenant F. B. S., aged thirty years. Infantry. April 22, 1918.

History.—Patient was caught in a barrage on April 19th, many large shells exploding in his immediate vicinity. Was unconscious for a few minutes, but later discovered that his face had been peppered and was swollen and blue. The vision of both eyes was blurred from the onset. The swelling about the eyes and lids was so great that he could not open them for some time. He was transported to Evacuation Hospital No. 1, and shell splinters were removed from the left temple. Patient has had measles, mumps, chicken-pox, scarlet fever in childhood. Pneumonia at seventeen years. Is constipated, subject to "heartburn," and has always had a little cough. Paternal grandfather died of pulmonary tuberculosis.

Present Condition.—Entire face peppered with small wounds, gravel, dirt, and tiny shell bits, and, together with the lids, swollen and puffy. The largest of the small superficial face wounds is 1 cm. in diameter, covered with a thick scab, and situated just below the right eye. Both eyes show marked traumatic conjunctivitis and subconjunctival ecchymosis. Ophthalmoscopy: Both eyes present large retinal hemorrhages, commotio retinæ, and numerous small areas of

retinal detachment, while blood extravasations into the vitreous are noted in the periphery of the right eye. Advised radiographic studies.

April 26, 1918: The patient says that his vision is clearing. After rest and indicated treatment an improvement is noted ophthalmoscopically, the retinal edema having subsided, the small, circumscribed retinal detachments having become reapplied, and most of the hemorrhages having been absorbed. There remain, however, two large, globular, black-bordered, old blood masses in the extreme inferonasal periphery of the right fundus. V.R.E., 20/100; L.E., 20/50; cycloplegia present.

Radiographic report: Small foreign body the size of a pinhead situated in the left orbit 12 mm. posterior to the center of the cornea; 16 mm. to the temporal side of the vertical plane, and 16 mm. below the horizontal plane of the cornea. This measurement put the foreign body in the orbit but outside of the globe. Small foreign body in right eye clinically palpated and found not intraocular.

April 30, 1918: The vitreous hemorrhages are rapidly organizing and the vision of the right eye has improved to 20/70−.

May 2, 1918: Under cocain anesthesia removed a small, non-magnetizable foreign body which was embedded in the sclera of the right eye beneath the belly of the internal rectus muscle.

May 4, 1918: V.R.E., 20/50; L.E., 20/30. This shows an increase in the visual acuity of each eye.

May 22, 1918: Ophthalmoscopy: Media clearer and fundus landmarks more visible. Dionin to further aid absorption.

May 27, 1918: Vitreous much clearer and fundus details easily studied. V.R.E., sph.+1.25=20/30. Discontinue treatment and discharge to duty.

Unfortunately for the patient, but fortunately for our follow-up records, he was again wounded, this time through the neck, shoulder, and abdomen, and was sent from Evacuation Hospital No. 1 to us on July 11, 1918. As soon as he felt equal to the tests the writer gave him a thorough overhauling and found the fundi negative and the vision of each eye, with correction, 20/20.

Diagnosis: Commotio retinæ, traumatic, bilateral; foreign body, left orbit and right sclera; retinal detachments, traumatic, bilateral; hemorrhages, retinal traumatic, bilateral; hemorrhages, vitreous, traumatic, right.

Private J. G., aged twenty-five years. Infantry. February 23, 1918.

History.—On the seventh of this month, about 4.30 A. M., patient's rifle grenade exploded and injured the left eye. It was dressed almost at once by the hospital corps man in the dugout, then at the first-aid station, which he left on the sixteenth for Field Hospital No. 12. Up to the time of admission here the eye had never been *x*-rayed. He was brought here today with the diagnosis: "Wound, lacerated and contused; severe, upper lid, left eye."

Present Condition.—The pupil of the left eye is dilated and fails to react to light, possibly due to previously instilled mydriatic. There is a small, vertically placed scar in the inferior sector of the cornea. No fundus details are obtainable with the ophthalmoscope. Right eye is normal in appearance. The vision of V.R.E., 20 20; L.E., hand movements, eccentrically, in the nasal field. *X*-ray, taken at once, failed to show any foreign body. Patient did not remain long enough in this hospital to enable the physician to note the progress and clearing up of the lesions.

Diagnosis: Macula of the cornea, left eye; probable intraocular hemorrhage, left eye; probable detachment of the retina, left eye; probable rupture of the retina, left eye; possible rupture of the choroid, subfoveally, left; possible hemorrhage into sheath of optic nerve, left.

Private C. E. C., aged twenty years. Infantry. February 23, 1918.

History.—A hand grenade exploded on February 2d, and several pieces struck the patient in the left eye. He was taken to Field Hospital No. 13, and the eye was treated, but not *x*-rayed. The lids were swollen shut and the eye pained considerably for two or three days. After three or four more days he was taken to Field Hospital No. 12, where the same treatment was continued, but no operation or radiographic examination made. In four more days the treatment was stopped and the eye irrigated every other

day and kept bandaged in the interim. Sent here today with the diagnosis: "Contusion, severe, over frontal and both orbital regions."

Present Condition.—Slight ptosis right upper lid, and almost completely absorbed subconjunctival ecchymosis, right eye. V.R.E., 20/20; L.E., "hand movements." Ophthalmoscopy, pupils not dilated: Right eye: Normal appearance. Left eye: Grayish, floating vitreous opacities which almost occlude the fundus reflex and quite preclude the study of details. Advised *x*-ray examination.

February 23, 1918: Roentgenologist reports foreign bodies in the region of both orbits—two in the left and one in the right orbit. The last, from its general location, is probably pressing upon the levator palpebræ superioris near its origin, and either mechanically or by disturbing local innervation, preventing the proper functioning of that muscle.

March 1, 1918: Vision as above recorded. Ophthalmoscopy: Right eye: Normal. Left eye: Practically as above noted, though considerable absorption of the opacities has occurred, and the red reflex is more easily discerned. The opacities have the appearance of the remains of an old hemorrhage into the vitreous.

March 4, 1918: It was decided not to attempt removal of the orbital foreign bodies in the belief that the left eye would gradually regain its vision and that the ptosis of the right upper lid would not grow worse, but might, on the contrary, be partially corrected by the encapsulation of the pressing foreign body and compensatory hypertrophy of the levator muscle. It seemed wise to aid this to a slight degree, so a very small elliptic section of skin and subcutaneous tissue was excised from the orbital portion of the right upper lid, a subcuticular stitch being run through.

March 8, 1918: The suture has been removed, the ptosis is much improved, and there is no ectropion.

Diagnosis: Foreign bodies, both orbits; probable vitreous hemorrhage, left eye; probable detachment of the retina, left eye; ptosis, traumatic, right eye.

Private H. M. C., aged twenty-one years. Infantry. February 3, 1918.

History.—Patient admitted from Camp Hospital No. 1

with diagnosis on transfer card: "Punctured wound of eye, right, suspected; accidentally incurred at manœuvers in France, January 24th, when he received a blow from a fragment of hand grenade." When a child, he was struck above the right eye, near the bridge of the nose, with a small bird-shot, which still remains subcutaneously and is quite easily palpable.

Camp Hospital history: About nineteen days ago patient was injured by an exploding hand grenade, a portion of the detonator striking the patient in the right eye, which bled profusely and immediately swelled until the lids were closed. Was treated in the company infirmary until sent here. After the swelling subsided sufficiently to permit of accurate examination, the eye was minutely inspected, but no lesion or point of injury could be found either in the globe proper or anywhere within the conjunctival sac. Some dirt particles were removed and the eye was noted as being considerably inflamed and painful. The vision of the right eye was reduced to mere light perception, and because this did not improve patient was sent to this hospital (Base Hospital No. 18), where the following notes were made:

The patient is perfectly well except for the injured right eye. The right eye is slightly swollen and the conjunctiva somewhat inflamed. The iris has a muddy look, and there is a circumcorneal injection, while fine, radiating corneal blood-vessels are detected. The anterior chamber is deep and tension lowered. Vision is entirely obliterated except for faint perception of light and form in extreme temporal field. The left pupil reacts normally; the right is dilated with atropin. Laryngologic and dental examinations negative. V.L.E., 20/20.

February 4, 1918: Ophthalmoscopy: O.D., media turbid, fundus reflex amber colored. Papilla and details of fundus slightly veiled, somewhat hyperemic and edematous. There are areas of pigment deposit in the retina and choroid, while the retina, temporal to the fovea, is slightly edematous. Impression of traumatic uveitis and commotio retinæ.

February 10, 1918: Ophthalmoscopy: Right eye: There are large, stationary, and floating vitreous opacities, and areas of retinal and choroidal edema and atrophy, while there is a distinct rupture of the choroid in the macular

region, with atrophy of the optic papilla and detachment of the retina. Left eye: Negative, save for engorged veins. Wassermann: Previously advised, reported negative.

Diagnosis: Commotio retinæ, right eye; rupture of choroid, right eye; detachment of retina, right eye; atrophy of retina and optic nerve, post-traumatic.

Optic Nerve.—Hyperemia of the disc, sometimes amounting to an absolute edema, was so commonly met with in those young, highly hyperopic men with distressing headaches and other aggravated asthenopic symptoms that it seems worth mentioning. The explanation seems to lie in the fact that most of them had never had their refractive errors corrected and had put up with their symptoms for years, the continual overwork of the ciliary muscle finally bringing about an increased irritability of all the adjacent tissues.

Others, great smokers, whose vision could never be made normal with lenses, were suspected of being incipient amblyopia cases with a rather mild, acute, retrobulbar neuritis and consequent papillary hyperemia, perhaps edema.

The out-of-door life and exercise probably prevented the more frequent occurrence of typical tobacco amblyopias, yet a few, with pale discs and suggestive histories and visual fields, were regarded as such cases.

Private S. P., aged forty-four years. Machine Gun Company. January 8, 1918.

History.—Distant vision is blurred and he is unable to read distinctly or to do any close work. Eyes ache after using present glasses. Patient smokes excessively. V.R.E., 20/50; L.E., 20/30−. Perimetry: Irregularly concentric contraction of visual form and color fields. No demonstrable scotomata or enlargement of blind spot. Homatropin, 2 per cent.

January 8, 1918: Ophthalmoscopy: Both papillæ pale and vessels thereon attenuated.

Refraction tests demonstrate considerable compound

hyperopic astigmatism. O.D. sph.+1.00 ⊂ cyl.+.75 ax. 90°; O.S. sph.+.75 ⊂ cyl.+.75 ax. 75°; the lenses failing to improve vision.

Diagnosis: Tobacco amblyopia.

Still another, an inordinate smoker, presented the following confusing picture:

Captain N. P. P., aged forty-three years. Infantry. September 6, 1918.

History.—Has been wearing glasses for near work during the last five years. Since being "gassed," July 18th, vision has been greatly impaired and cannot focus quickly enough to judge distances. Sharp temporal headaches occur periodically. Has had malaria several times. F.O.H. negative. Has trouble in breathing at present. Patient apparently of extremely high-strung nervous temperament.

Present Condition.—Congestion of inferior and superior palpebral conjunctivæ, both eyes, excessive lacrimation, extreme photophobia, and blepharospasm. Pupils react actively. V.R.E., 20/100; L.E., 20/100. Homatropin, 2 per cent.

September 7, 1918: Ophthalmoscopy: A few fine vitreous opacities: The disc is pale, its details blurred and margins ragged, presenting the typical, dirty-looking appearance of post-choroidoretinitic atrophy. Static refraction: O.D., cyl.−2.00 ax. 180°=20/30; O.S., cyl.−2.00 ax. 165°=20/40− −. Perimetry: Negative save for slight, irregularly concentric contraction of color fields.

Advised urinalysis, Wassermann, blood tests, neurologic and dental consultations. Later, Wassermann positive plus, plus. All other examinations negative.

Diagnosis: Myopic astigmatism; lues.

The writer has seen so many cases of this type that he feels it to be a dereliction of one's duty not to have a blood, and if necessary spinal fluid, Wassermann in all cases evidencing retinovascular or papillary ophthalmoscopic abnormalities, no matter how vague and slight in degree.

Pallor of the disc was observed rather frequently in the

sick, wounded, debilitated, or those who had lost much blood, as well as in many of the anemic individuals from the malarial and hook-worm sections of the United States. The characteristic picture of early, unequal, partial, temporal atrophy enabled the examiner to differentiate several multiple sclerosis suspects from the refraction clinic, and their histories are here appended as of possible interest:

Private P. D. H., aged eighteen years. Machine Gun Company. May 28, 1918.

History.—Eyes first began to oscillate last September, at which time an oculist in New London, Conn., examined him, and diagnosed "compound astigmatism"; as the patient refused to wear glasses, the oculist treated his eyes. After this regimen they remained normal for six months, at the end of which time the oscillation began again and he experienced sharp, shooting frontal pains as well, with "dizzy spells" later developing as an additional feature. Now all these symptoms are present, somewhat aggravated by a recent attack of conjunctivitis, and, in addition, objects regarded intently seem to jump and dance, print soon blurs after reading for any length of time, while the eyes pain and are photophobic. The previous medical history, the family medical history, and the family ocular history are negative. Usual childhood diseases.

Present Condition.—There is a marked nystagmus, horizontal and semi-rotary in type, *i. e.*, with an inclination of the vertical axis of each eye to the right oblique and back to the vertical. Occasionally this ceases for a few minutes, particularly when looking far to the right or left. The patellar reflexes are impaired, and there is a slight sway when standing with the feet together and the eyes shut. The pupils react sluggishly to light. The teeth are badly in need of repair. V.R.E., 20/50; L.E., 20/30. Atropin, 1 per cent. Advised Wassermann blood test, neurologic and dental consultation.

May 31, 1918: Ophthalmoscopy: Slight pallor of the temporal half of each optic papilla, more marked in the right than the left eye. Static refraction: O.D., sph.+2.50 = 20/40; O.S., sph.+2.75 = 20/30++. Perimetry: Slight

concentric contraction of both visual fields for form and color. No enlargement of the blind spot. Wassermann negative. Multiple sclerosis suspected because of the unequal, partial temporal atrophy, the history, and visual fields.

Neurologic consultation: Nystagmus, horizontal and rotary, to the right. Other cranial nerves negative. All deep reflexes present, active, and equal. Superficial reflexes all present. Beginning ankle clonus on left; pseudo-clonus on right. No Babinski.

Private J. C. S., aged thirty years. Marine Corps. March 7, 1918.

History.—Chief complaint, "nervousness." The patient landed in France on August 20, 1917, and went through the drills for the next two days, since which time he has not been able to drill. For ten days after landing was in the Base Hospital at St. Nazaire. Entered Base Hospital No. 5 in the following November and remained there for five weeks. His condition was not improved by his two hospital sojourns. He is now bothered by sharp, shooting pains which begin in the calves of the legs and travel upward and downward. These are more marked in the left leg. Furthermore, he has girdle-like "lightning" pains around the abdomen. Has knife-like pains in both shoulders and occipital headaches. All pains, as well as the headache, are worse at night. At times is annoyed by an uncontrollable stammering, often becomes very dizzy, and has extreme difficulty in locomotion, particularly in the dark. He had mumps in childhood, "jaundice," and a fractured radius at fifteen years of age. His father, mother, and two sisters died of unknown causes. One sister died of apoplexy. One sister is living, but a victim of rheumatism.

Present Condition.—Slight nystagmus. Pupils react normally to light and accommodation. Marked tremor of hands and decided "intention tremor." Tongue, protruded in midline, is tremulous. Heart and lungs are negative. Both testicles atrophied. Reflexes: Biceps and triceps, plus plus. Abdominal, absent; knee-kicks and ankle-jerks, plus plus. No clonus. Babinski negative. Romberg positive. Gait is "staggering"; patient cannot walk with eyes closed. There

is some impediment in speech, though no distinct stammering. Ophthalmoscopy: Right eye: Nothing definitely pathologic, except that the arteries are pale, have lost their transparency, and are tortuous, while their perivascular lymph-spaces are glistening, infiltrated, and not transparent. Along and bordering the inferior retinal vessels is a zone of retinal edema and inflammation, apparently a localized neuroretinitis. Superior to the fovea and within the macular region are two or three small, discrete, white spots. Left eye: The same general arterial appearance is noted, though the neuroretinal changes described above are wanting.

Urinalysis and blood Wassermann advised. Both returned negative. Spinal fluid Wassermann later tested, with the same laboratory report.

Diagnosis: Multiple sclerosis, early.

Papillitis and papilloedema were not frequently witnessed. Fractured skulls with pressure, intracranial foreign bodies, and brain abscesses, as might be imagined, were usually causative. Occasionally lues was observed, but the retinal vascular changes were by far the commoner syphilitic picture, though the following combined both features:

Private J. T. C., aged twenty-two years. Infantry. January 11, 1918.

History.—Patient gives a history of lues and positive blood Wassermann; four subsequent injections of neosalvarsan, also mercurial inunctions, dating from March, 1917, to his discharge as cured in October following, the Wassermann remaining negative, the last test a few days ago. About December 15th the sight of the left eye began to blur and he had severe headaches. Since then the vision has continued blurred, and he has, in addition to headaches, twitching of the lids of both eyes and morning gluing of the lids. Had pertussis, measles, and varicella in childhood. Denies gonorrhea. His mother died at twenty-four years, cause unknown, and one brother died at eighteen years of Bright's disease.

Present Condition.—Both pupils react to light, accommodation, convergence, and consensually, the left somewhat

sluggishly. V.R.E., 20/30; L.E., 20/200. Advised blood Wassermann.

January 13, 1918: Ophthalmoscopy: Right eye: There is a bright, pinkish hue to the retinal arteries and a definite loss in transparency of their walls, while the central light-streak occupies almost the whole width of the vessel, and faint, glistening lines of perivascular infiltration accompany some of the major branches. There is a normal, punctate, bright, foveal reflex. Left eye: The same general condition as above noted, with the addition of hyperemia of the papilla and slight edematous filling of the physiologic cup, both rendering disc details and margins blurred. Retinoscopy: O.D., cyl.+.25 ax. 90°; O.S., sph.−.25⌔cyl.+.50 ax. 90°. Static refraction: O.D., cyl.+.25 ax. 120° = 20/20; O.S., no improvement with any lens.

Wassermann negative. Unfortunately, circumstances did not permit the test of the spinal fluid or the examination of the visual fields.

Diagnosis: Papillitis and retrobulbar neuritis, left eye.

Injuries of the optic nerve, either direct or indirect, without injury to the globe, were not infrequently seen. Occasionally this was due to the pressure from a large orbital foreign body with slowly descending atrophy, now and then to a fracture involving the optic canal with trauma to the nerve, and more commonly to the jarring incurred by the reception of retrobulbar, orbital foreign bodies or by the transmission of waves of force from wounds of the surrounding bony structures, hemorrhages into the sheath of the nerve having been thought the most likely cause for the blindness or partial amaurosis which ensued.

These various types are exemplified in the following histories, particular attention being called to that of Sergeant W. H. Z., the first man blinded in the United States army, according to the story of his subsequent convalescence as published in the first number of the War Department's magazine, "Carry On," because he represented, no doubt, the rather rare occurrence of hemorrhage into the sheath of

the optic nerve from the elevation of the general venous blood-pressure. Two other cases of traumatic asphyxia of similar origin were observed by the writer, though one died shortly after admission and complete blindness did not ensue in the other, the ocular hemorrhages being restricted to the subconjunctival space.

Sergeant W. H. Z., aged thirty-one years. Advanced Ordnance Depot No. 1. November 3, 1917.

History.—Patient was driving a motor truck which skidded down a hill and tipped over, pinning him beneath, and compressed his lower abdomen. He was soon pried out by his companions and rushed to Field Hospital No. 12, where the diagnosis "possible fracture of one rib and injury to spine and bladder" was made, and patient immediately sent on to this hospital. The patient has spent four years in the tropics (Philippines, 1911–1915), has been a moderate user of alcohol, but has always enjoyed excellent general health and denies venereal history. Broke his left shoulder two and a half years ago. Father, mother, two brothers, and one sister living and well. One brother died of spinal meningitis. No history of tuberculosis.

Present Condition.—Patient is quite ill and presents a classic picture of traumatic asphyxia: Deep, dusky color, more marked over face and neck, the tissues being swollen and discolored from the diffuse peripheral hemorrhages. Lids purplish and swollen, so that eyes are closed. Complete bilateral subconjunctival ecchymosis. Ophthalmoscopy: Retinal edema, bilateral, with a few small scattered retinal hemorrhages, one in the macular region of the left retina. Patient at this time too ill to test vision. He did not complain of diminished visual acuity until several days later. In the mean time he was operated upon for fractured pelvis and traumatic rupture of the bladder, the surgeon achieving an excellent result, though the convalescence was delayed by the development of a bronchitis.

During this interim the eye-grounds were frequently studied and the absorption of the hemorrhages was noted, as well as the gradual atrophy of the disc, manifested particularly in attenuation of the vessels and paleness, with

decrease in level of the temporal sector of the disc and loss in retinal sheen. He rapidly became quite blind, save for a tiny area in his right inferotemporal visual field, which could be quite clearly mapped with the perimeter. Those who have seen him more recently in the United States, where he was treated at General Hospital No. 7, tell me that this latter area has entirely disappeared, and that he is totally blind.

It was felt that his retinal hemorrhages could account for great loss in visual acuity, especially the macular hemorrhage in the left eye, but as they absorbed and his vision grew steadily worse, other collateral explanations were sought and the examiner cogitated the possibility, or probability, of hemorrhages into the sheaths of the optic nerves, with pressure upon the latter and secondary descending optic nerve atrophy, as well as the post-retinitic variety. This could be given no more value than the most plausible of many unproved hypotheses. The case is principally quoted to illustrate the more serious ocular complications of traumatic asphyxia. There have been several such cases in this clinic from crushing by overturned caissons or limbers, collapsed dugouts, and similar accidents, some dying too soon for mature studies to be made, others having no more than a mild facial duskiness and subconjunctival ecchymoses.

Private C. R. P., aged twenty-eight years. Signal Corps. September 18, 1918.

History.—Was knocked unconscious in an automobile accident nine days ago. Thinks the left side of his face was struck by the car because it swelled almost immediately and the vision failed in the left eye at the same time. As the swelling subsided he became aware that he was totally blind in that eye. The pain was very intense at first, being superseded by a headache which lasted four or five days, while he now feels as if a tight band was around his temples. Immediately after the accident he bled from the nose and mouth, but after vomiting steadily for about an hour, the bleeding ceased. In childhood had measles, mumps, and whooping-cough; typhoid at twelve years. Malarial fever three years ago, cured by vigorous quinin therapy, from which patient never noted any deleterious influence upon vision. Nocturnal enuresis at thirteen years, cured by circumcision.

One brother died in infancy. A paternal uncle died of pulmonary tuberculosis. Patient now feels well except for a tightness in the head on coughing and difficulty in gauging distances, attributable to the blind left eye. Diagnosis on transfer card from Field Hospital No. 13: "Contused wound of left supraorbital region, moderately severe."

Present Condition.—Well-nourished individual. Inguinal glands hard and shot-like. Ophthalmoscopy shows atrophy of the left optic papilla, probably due to fracture of orbital

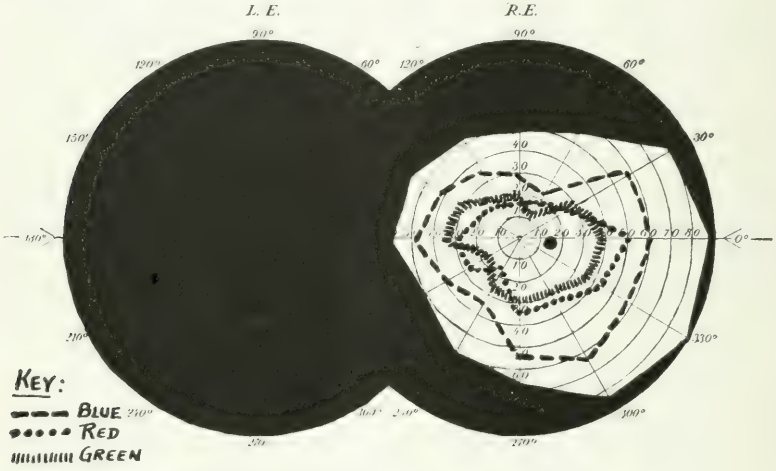


Fig. 2.

wall through optic foramen, with severance or compression of optic nerve. V.R.E., 20/30−; L.E., total amaurosis.

Perimetry: Fig. 2.

Static refraction: O.D., sph.+.25⌓cyl.+.25 ax. 165° = 20/20−. Ophthalmoscopy: Right eye: Negative. Left eye: Pallor and atrophic concavity of the entire nerve head. Advised radiography and urinalysis.

September 18, 1918: No evidence of foreign body. There seems to be irregularity at the top and bottom of the left orbit, and it is suspicious of a fracture. Urinalysis negative.

Diagnosis: Primary descending optic nerve atrophy, left eye, following fracture of the orbit.

Private A. S., aged twenty-five years. U. S. Marine Corps. July 9, 1918.

History.—At Bois de Belleau the patient was shot through face by a machine-gun bullet which entered at the lower edge of the right nasal sinus, emerging beneath the left zygomatic arch.

Present Condition.—V.R.E., 20/20; L.E., S 200. Ophthalmoscopy: O.D., negative. O.S., media clear, save for a few partially organized floating vitreous hemorrhages. The papilla is paler than normal, the retinal vessels attenuated and apparently decreased in number. There are a few small scattered areas of retinal detachment and hemorrhages in the macular region, as well as the periphery. There are numerous disseminated choroidal hemorrhages and pigment changes; about 1.5 disc diameters superotemporal to the disc, there are several typical ruptures of the choroid, the underlying white sclera and the overlying retinal vessels being clearly discerned.

Impressions: In addition to the above noted intraocular changes, a fracture of the floor of the orbit was suspected, with probable involvement of the optic foramen, and a commencing descending optic nerve atrophy, the vision of the left eye having gradually grown worse under observation until the patient was evacuated farther back.

N. B.—Under post-traumatic atrophies one might profitably refer to the histories of Privates H. M. C. and J. G., recorded previously under Retinal Traumata.

Orbit.—Cellulitis and periostitis, as encountered in the strumous children and youths who visit our civilian clinics, were seldom seen in the army, but infection from without was quite common. When one comprehends that projectiles not only tear the globe to pieces, but pierce the septum orbitale, churn up the fat, and often embed themselves in the orbital wall or perforate one or more of the sinuses, it is readily appreciated that dirt is pretty thoroughly disseminated throughout these non-resistant and rudely traumatized tissues, and because of this post-operative convalescence is often somewhat complicated.

Usually foreign bodies in the orbit, if not infected, cause no inconvenience and should be left *in situ*. (Refer to history of Private R. D. D. under Traumatic Iritis.) As will be seen elsewhere in this paper, the optic nerve is occasionally pressed upon by a foreign body, which has usually brought up against the posterior orbital wall at the lip of the foramen and leans against the nerve-trunk, necessitating removal to save vision. Foreign bodies may lodge in the apex of the muscular cone, restricting bulbar excursions, or rest upon an isolated muscle, such as the levator, impeding its contraction and causing a slight ptosis, as in the case of Private C. E. C., quoted under Retinal Injuries. Another good example of intraorbital foreign body is furnished by the case of Private J. A. G., given under Sympathetic Irritation.

The most important of the orbital complications is fracture, particularly if it involves the optic canal, as in the case of Private C. R. P., quoted above. The following illustrates an interesting contre-coup fracture of the orbit without change in the nerve but involving the cavernous sinus and carotid or ophthalmic artery, allowing the arterial pulse wave to pass directly into the local venous system and producing a beautiful pulsating exophthalmos, eventually cured by operation.

Sergeant G. F. B., aged thirty years. Wagon Company, Engineers. July 11, 1918.

History.—Previous medical history negative save for scarlet fever in childhood and gonorrheal urethritis five years ago. On June 3, 1918, while riding a mule, collided with a rapidly oncoming motor-cycle. Was either struck or kicked over the right anterior temporal region, inflicting a deep gash in the flesh and causing a linear fracture just below the supraorbital ridge with involvement of the outer table only. At this time he was brought into Evacuation Hospital No. 1 quite unconscious, and with Cheyne-Stokes breathing, while "partial right-sided paralysis and mental sluggishness" were recorded.

The roentgenologist reported "fracture of right frontal region"; he was immediately operated upon, without an anesthetic, and the operator found a "fracture of frontal bone just below right supraorbital ridge." He made a trephine opening in the skull, noted that the inner table had not been fractured and that the pressure and pulsation were normal. For three weeks the patient was unconscious. A "right-sided facial paralysis and flaccidity of the right arm and leg" were noted, and the patient reported in "very bad condition." The daily notes chronicled a rather interesting convalescence: "Restless, unconscious, pulse 70 and 60, difficulty in taking fluids or food, voids urine involuntarily;" while the paralysis was reported to have "cleared up before consciousness returned," the "mental sluggishness" persisted, though to a lesser degree. At this time examination showed "paralysis of the third nerve of the left eye and slight papillitis," the right eye being normal. Two weeks after the accident it was noticed that the "paralysis of the right arm and leg was gone," but that he was still "dazed and unable to respond to questioning." A ptosis of the left eyelid and a "bulging of the left eye base" were observed. The ward surgeon made this diagnosis: "Linear fracture outer table, right temporal bone; right-sided paralysis."

July 11, 1918: Patient admitted to Base Hospital No. 18, where the following findings were recorded: Right eye: Slight congestion of the superior and inferior palpebral conjunctiva, vision 20 30 plus plus; otherwise eye perfectly normal. Left eye: Marked evidences of typical pulsating exophthalmos; great engorgement of the palpebral and bulbar conjunctiva; extensive chemosis, particularly inferiorly; lagophthalmos and haziness of the corneal epithelium; definite restriction in the movements of the globe; vision 20/60; pupillary reactions normal. Ophthalmoscopy: Right eye: Negative. Left eye: Retinal veins dark and distended. Disc margins a trifle blurred. Fundus noted as physiologic despite the slight veiling of all details owing to the dryness and haziness of the exposed corneal epithelium. Perimetry, urinalysis, and Wassermann negative. Dental and laryngologic consultations fruitless.

X-ray reports: "Right frontal bone shows an area of increased radiability due to removal of bone from that area.

The frontal, sphenoid, ethmoid, and maxillary sinuses are clear. There is no roentgen evidence of change in the region of the sella. Linear fracture nasal side superior border of left orbit."

August 24, 1918: Exploratory operation, left orbit, negative results. While testing patient's vision it was evident that he could read some letters, though small, with ease, whereas others, even of the largest size, he could not name. However, he could draw an exact copy of the missed letters as well as assure the examiner that he knew and could see the letters very well but could not name certain of them. He showed his diary, which he had been keeping up, day by day, of late, and demonstrated that he could write perfectly what originated in his mind, but could neither read it aloud nor write perfectly from dictation. For example: the examiner asked him to write "Base Hospital," and he wrote, instead, "Tase Hospital"; again, he was told to write "this is a fine day," but spelled day "Fay" instead. Because of this latter mental confusion he was sent to the neurologist, Dr. Casamajor, in consultation. Diagnosis of arteriovenous aneurysm, traumatic in origin, and probably of the internal carotid artery and cavernous sinus, was made, and the patient transferred to Base Hospital No. 50, farther back, on August 24th, space being needed for more urgent cases. The examiner wrote advising that, should pressure bandage and compresses effect no improvement, the left internal carotid artery be ligated. This was done on September 23d, his physician informed the writer, while another letter from the same officer, dated October 4th, qualitatively reported good progress, that the vision in the proptosed eye had greatly improved, and that the exophthalmos was almost gone. Other letters, October 23d and 31st, recounted still greater improvements, bordering upon cure, and informed this clinic of his reclassification and shipment to the United States on the ground of his mental condition.

Ophthalmoneurologic Conditions.—Amaurosis of central origin was of relative rarity in our army, and the writer thinks the large series presented by Gordon Holmes resulted from the fact that steel helmets were not worn in the earlier days of the war, and trenches were not as deeply excavated

or as highly ramparted, so that head injuries were more common. From the start all possible was done, by education and employment of protective devices, to guard our men against unnecessary head wounds.

In the summer of 1917, when our troops first landed in France, a committee discussed a model helmet based upon the best points of those in vogue in the various armies. The writer was asked to look at the models preferred by the committee and to glean informally the opinion of allied ophthalmic colleagues upon the merits, demerits, and possibilities of the various forms in use. The result of his investigations are briefly given in this extract from his letter to Colonel Wadhams, written in August, 1917:

In compliance with the advice of Colonel Barker and yourself, who were so kind as to instruct me in the measures advocated by your committee for the protection of soldiers' eyes, I am writing to tell you, briefly, what seems to be the present state of the subject in the minds of the French and English oculists, and to inject a personal suggestion into the plans, discussion of which, I am led to believe, is still open.

I have seen all the French paraphernalia (protective goggles, glass and mesh masks, visors, etc.), as well as our own proposed helmets and visors. At Hospital Lariboisiere, where Professor Morax and Dr. Moreau have gone so thoroughly into the subject by theory, experimentation, and actual practical observation over a long period of time, the conclusion now seems to be that, despite the infinitely better ocular protection afforded by the visor, the even partial occlusion of direct vision is dangerous, and often disastrous, inasmuch as the fighter is handicapped and cannot see to dodge large approaching missiles (grenades, oil-cans, etc.), or to defend himself in case of hand-to-hand encounters with enemy raiders. Hence they seem to feel that it would be wiser to compromise and shield the eyes from the sides, leaving a small, clear hole ahead for direct, unobstructed vision. Furthermore, the visor formerly used and now adopted experimentally by the committee is detachable, and the already overburdened "Poilu" pulls it off and throws it

away, or, as a "Tommy" remarked to me: "We jes' dumps 'em" (referring to protective devices), so that it would seem wise, as you also suggested, to have the visor made non-removable. (In this connection they suggest, at Lariboisiere, that protectors be kept in charge of a responsible non-commissioned officer who shall distribute them to or collect them from his group of men at proper times.)

It was pointed out that damage to vision was often caused by contre-coup, striking the orbital margin, the brow, etc., and rupturing the choroid or retinal vessels, and that a broad, heavy goggle-mask, fitting closely to the temples and forehead, was required, but it strikes me that this danger is inappreciable as compared with the damage from direct hits with small particles (especially with the now-prevailing contact-explosion shrapnel), and, as you and others have pointed out, small particles are responsible in about 50 per cent. of cases, besides which pieces sufficiently heavy and traveling at such velocity as to cause contre-coup would penetrate the protectors which I saw or transmit the same amount of violence through them. (In this I am supported by many ophthalmic surgeons with whom I have, in the past few days, discussed the situation.) Thus our visor seems preferable to this protector.

The Cruise chain protector, used formerly by the British, considered by your committee and abandoned because of a number of objectionable features, has been carefully studied by its inventor, in the light of its former drawbacks, and is now being perfected most satisfactorily, I am told by Colonel Lister, who has recently seen Cruise and gone over the subject with him. The tell-tale rattle has been overcome and there is no looseness; it can be detached from the right eye and hooked over the left alone, when it becomes necessary to "snipe"; it is steadied in place by a stiff nose-piece; the whole can be everted over the brim of the helmet; and, whether before eyes or over helmet's brim, it fits firmly and neatly because of a spring at each point of attachment to the helmet.

The advantages of this, then, would seem to be: Complete protection of both eyes against small particles, when in place, with reasonably good vision; double protection of left eye while full vision and usefulness is obtainable with

right; firm, unhindering attachment to helmet with less desire on part of soldier to "dump" it during an assault.

From all that I can gather, there has been no definitely organized or well-formulated effort (from military sources) to check up the value of the protectors, the proportion of eye injuries among a certain number of troops exposed to the same attack, a certain per cent. with and an equal per cent. without protection. Therefore any effort such as yours, directed toward facilitating such comparative studies, is most laudable. To this end I would suggest that you have an investigation made of this modified Cruise chain protector, which is about to be reintroduced, and that, if you deem it worthy of trial, you consider ordering the same number as has been ordered of the visors (10,000 visors to 200,000 helmets, I believe), after which the comparative protecting values of the two will soon be evident and you will know which to standardize for our army. Then we shall see your splendid plans for the protection of our soldiers' eyes, so sporadically and unsystematically entered into by others, come to satisfactory fruition.

Another reason for failing to see many cases of amaurosis of central origin was owing to the fact that head cases did not long remain in this hospital center, but were sent on, almost immediately, after barest surgical recovery, to bases more remote, so that patients were seldom well enough, or sufficiently long in hospital, to permit of conducting those protracted and fatiguing tests necessary for procuring the proper ophthalmologic data.

A handful of such cases have, however, fallen to our lot, and brief mention will be made of them, the fact that they essentially belonged to the neurologist, who proposes reporting them, precluding detailed summaries:

One of the clearest and most instructive of them was Private C. K., with a wound in the left parieto-occipital region, and a radiographically demonstrated intracranial bullet, localized by perimetry, sensory disturbances, etc., exactly in the posterior inferior ophthalmic nucleus (Fig. 3).

Private DeF. R., aged nineteen years. Infantry. July 20, 1918.

History.—Vision of left eye greatly impaired since having typhoid at two years of age. Left eye was crossed and was operated upon successfully years ago. On June 11th shrapnel exploded, striking him in the right parieto-occipital region. Since then has had no vision in left eye. Has worn glasses constantly since childhood; broken nine months ago. Has continuous frontal and occipital headaches. When reading, print overlaps, and eyes lacrimate excessively. Nose

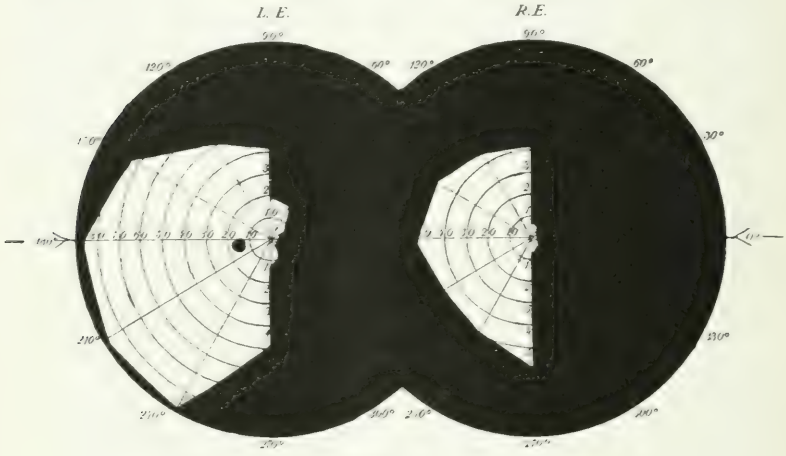


Fig. 3.

broken when sixteen years old. Grandmother blind, does not know cause. All members of family wear glasses. He is a patient here because of several other gun-shot wounds.

V.R.E., 20/30; L.E., hand movements in temporal field.

July 23, 1918: Ophthalmoscopy: Negative. Static refraction: O.D., sph.+2.75⊂cyl.+.25 ax. 90°=20/30++; O.S., sph.+5.50⊂cyl.+1.00 ax. 90°= no improvement.

August 3, 1918: Perimetry: Shows small retained temporal field of the left eye.

Another case of unusual interest, as typifying a sort of word-blindness or motor aphasia, was that of Sergeant G. B., just quoted as an orbital fracture involving the

cavernous sinus, which is also to be reported by the neurologist and, consequently, will not be entered upon here.

Hysteric amblyopia was often seen, though diagnosed with difficulty from simulation. The visual fields and allied tests employed in ordinary civil practice usually clinched the diagnosis. Most of these cases came from the special base hospital for the so-called "shell-shock" cases, and the cures effected by simple lenses and mere suggestion were positively marvelous. Some patients, while undoubtedly amateur malingerers, were of a hysteric type, hence were given the benefit of the doubt and called hysterics, the following being two characteristic illustrations:

Private W. G. G., aged twenty-eight years. Infantry. July 12, 1918.

History.—Vision of left eye has always been poor. Has sharp, shooting supra-orbital and temporal headaches periodically. Sees black spots in front of eyes. Eyes are very sensitive to light. Had severe hemorrhages one week ago. Thinks boxing affected vision of left eye. Eyes were operated on at twelve years for chalazia. Childhood diseases. Father had cataract in left eye. Mother wears glasses. Finds that it is an effort to breathe at present.

Present Condition.—Chalazion, left lower lid. Pupils react to light, but sluggishly. V.R.E., 20/100 plus. L.E., blind.

July 13, 1918: With left eye, patient says that large letter, upon closer and more insistent questioning (20 200 line), looks black, blurred, and indistinguishable, and that he cannot see features well, but that he can tell the face from the body, adding that, while vision is poor at night, he can count stars. V.R.E., 20/70−; L.E., 20/200. Atropin, 1 per cent.

July 18, 1918: Ophthalmoscopy: The retinal vessels show considerable infiltration of their perivascular lymph-sheaths and loss in transparency of walls, the impression being a slight arteriosclerosis.

Retinoscopy: O.D., sph.+3.75; O.S., sph.+7.00 ⊃ cyl.+.75 ax. 120°. Static refraction: O.D., sph.+2.75. V.=20/20. O.S., sph.+6.00⊃cyl.+.75 ax. 120° =4/200.

Perimetry: Negative.

Diagnosis: Hyperopia, right eye; compound hyperopic astigmatism and amblyopia exanopsia, left eye; simulation of amaurosis, left eye.

Private L. S., aged twenty-five years. Infantry. July 12, 1918.

History.—Patient says vision of right eye has been gone for last five days, vision of left eye being greatly blurred. Eyes first started to smart and burn and the vision gradually diminished. Dull supraorbital pain periodically. Scarlet fever six years ago. Father became totally blind; does not know cause. Has a sharp, sticking pain in each lung and coughs constantly.

Present Condition.—Right pupil slightly dilated from previously instilled atropin. Reaction of pupils to light present.

V.R.E., blind; L.E., 20/100−.

N. B.—Patient volunteers the information that with the right eye he can see well at night, discerning moon and stars, further acknowledging that he can recognize people's features. Under those conditions examiner told the patient he did not believe there was much the matter, but was going to the bottom of the case and not leave a stone unturned to prove definitely whether or not his right eye was blind.

July 13, 1918: Patient entered clinic crying, but can now read much better, which is pursuant of examiner's rather pointed advice. V.R.E., 20 100; L.E., 20 70. Examiner believes patient really sees more because he calls out two letters in 20 70 line, but in inverted order. Orthophoria of extraocular muscles. Ophthalmoscopy: Glistening lines along the papillary course of the retinal vessels, and numerous punctate, scintillating spots of exudate in the macular region, more marked in right than in left eye.

July 18, 1918: Patient seems most anxious to please and says his vision has already improved greatly. Retinoscopy: O.D., sph.+.50⊃cyl.+.50 ax. 90°; O.S., sph.−.25⊃cyl.+.50 ax. 90°. Static refraction: O.D., cyl.+.25 ax. 90° = 20 20; O.S., plano = 20/20.

Urinalysis: Negative. Perimetry: Negative.

Diagnosis: Amaurosis, simulated, and hyperopic astigmatism, right eye; emmetropia, left eye.

Pretended Amblyopia.—With the high type of individual in our relatively fresh, vigorous army, simulation was not very common, but occasional instances occurred, and the visual tests employed at home, plus changes and modifications suggested by the exigencies of the particular case or of the environment, sufficed to reveal them.

Usually the attempts were poorly staged and the rôle ill prepared, oftentimes the patient having some real ocular derangement of a more or less mild nature and deciding to make the most of it.

They seemed to travel in pairs, occasionally flocks, as "birds of a feather" have ever done, and one leading spirit had evidently suggested the course to other less ingenious and vicious fellows, as shown by the two cases just cited.

As a rule, such examinations as a thorough testing of the visual fields made a great impression, a stern but slightly veiled intimation that you suspected them and would prove it on the morrow at their next testing, with a pointed insinuation as to the advisability of their showing a marked improvement on that occasion, sufficed, and within twenty-four hours they were usually sufficiently normal to return to duty, for which they seemed, paradoxically enough, now quite anxious.

For malingerers one cannot but have a feeling of pity, although mixed with scorn, and the examiner often wonders whether the mere fact that an individual endeavors to simulate does not mean that he is mentally abnormal and possibly in an early stage of some later neurosis.

Some who have been detected purposely inflaming their eyes to prolong their hospitalization, when taken aside by the writer and told what penalty could be inflicted and given another chance to redeem themselves, with a stirring appeal to their manhood and pride, have wept like children and asked to shake hands and be given the chance to prove their worth.

Though not desiring to moralize, the author wishes to add that the simulator seems the most pathetic picture in the whole gamut of odd characters in life, and that from his experiences with them he is inclined to agree with Harrison: "They are all good if you give them the chance," and with the verity of the hackneyed but splendid, "A mon's a mon for a' thot."

The most vicious type is the cold-blooded, intelligent, well-educated man whose environment and traditions have been of the best, and for whom there seems but little excuse. Such was the following:

Private H. C. B., aged twenty-three years. Engineers. November 5, 1918.

History.—Patient states that three days after a hard day's work he suddenly felt his left eye turn askew and was immediately aware of seeing double. He has a remarkably clear conception of the exact nature and location of his malady, and can with ease tell the recorder which is the true and which the false image. This complete comprehension of the mechanism of diplopia may be accounted for by the fact that, prior to his army career, patient taught physics in a technical school. Has had no pain. Aside from scarlet fever, previous medical history and previous ocular history are negative. Family medical and ocular histories also negative. Has always been more or less "on edge," but is in fairly good physical shape.

Present Condition.—The cover test reveals the left eye slightly up and out in position of rest. The fundi are normal, the vision of each eye 20/20, there is no ptosis, the bulbar excursions are equal, concomitant, and unrestricted, though with the slightest suggestion of infra-adduction on the part of the left eye. General neurologic examination negative.

November 6, 1918: Diplopia field diametrically contrary to that obtained on admission.

The first would point to predominant involvement of the superior rectus of the left eye, the second to the superior oblique. Patient always keeps left eye closed when up and about. Following these tests patient was studied in every

possible way to determine the etiology, but no discoverable cause for paralysis of the extrinsic muscles could be made out. These were made in spite of the examiner's suspicions that the patient was simulating.

Many times, and with numerous variations, was the diplopia field charted, with the red glass over one eye and then another and with the images still more widely separated by prisms. Always it was noticed that the patient would shut one eye and "get his bearings," and that his lips would be moving in time to his rapid mental calculations for some moments before he would answer. He could always figure out the change and then base his answers on his well-learned basic rôle.

Finally the examiner tested him lying first on his right side, with the red glass over right and then left eye, and then on his other side, with the same variations, in addition to which he made the patient answer promptly just exactly what he saw, without time for calculations. As the candle appeared horizontal, and as he had made his plans for vertical and obliquely vertical images, he could not, at a moment's notice, adapt himself to the new order of things, and consequently began to guess, thereby making a perfect "fizzle" of it and giving himself away.

Night-blindness, described most characteristically by the patients, was a very common symptom, and usually found with high degrees of refraction error. Never, in practice at home, has the author heard it so definitely and generally complained of, and he is at a loss for an explanation unless it can be laid to the tendency of youth to exaggerate in describing sensations. Quite properly it accompanied those rarely occurring cases of xerosis conjunctivæ, pigmentary degeneration of the retina, old choroiditis, and post-retinitic atrophy.

Interesting organic scotomata occasionally occurred, and were oftenest luetic in origin:

Sergeant J. G., aged twenty-seven years. Engineers. January 27, 1918.

History.—Patient sent in for eye examination because he noticed yesterday that central vision of the right eye was obliterated. Except for some lacrimation of both eyes during the previous ten days, patient had noticed nothing wrong with them, whereas argyrol at the time cured the watering. A subcoronal sore appeared on the penis in the latter part of September, 1917. As he was on the transport at the time of discovery, no treatment was undertaken save zinc ointment locally. Patient had had four Wassermann tests made at Texas City in October, 1917, on account of "bubo," but all were negative. Gonorrhea seven years ago. About eight weeks ago a rash broke out over entire trunk. This was treated locally and gradually faded, leaving brownish stains. The voice became hoarse at the same time, and has continued so to date. Aside from the obliteration of the central vision of the right eye and huskiness of phonation he feels perfectly well.

Present Condition.—Patient is well developed and appears in good physical condition. Has general glandular enlargement, scar of old sore on dorsum of penis, trunk covered with a macular, coppery rash, especially over abdomen, and ulcerative pharyngitis and laryngitis. The pupils are equal and react to light, accommodation, convergence, and consensually.

There is a marked weakness in the wrinkling power of the left eyebrow, probably due to a severe blow which was received over the left brow in 1917. There are no neurologic evidences of increased intracranial pressure. The eyegrounds show binocular hyperemia and edema of the papilla. Requested Wassermann. Provocative salvarsan injection.

January 28, 1918: Wassermann positive, 100 per cent. Since the above notations, there have developed bilateral circumcorneal congestion, photophobia, and ocular pains, slight in the right and much more marked in the left eye. In addition to this the ward surgeon reports the onset of a luetic orchitis. Advised another Wassermann.

January 29, 1918: Wassermann taken twenty-four hours after provocative salvarsan reported quadruple plus.

V.R.E., counts fingers eccentrically at 33, cm.; L.E., 20/40− (atropin).

Ophthalmoscopy: O.D., hyperemia and edema of disc with

retinal edema extending to and around macular region. O.S., marked edema of papilla.

January 30, 1918: Scotoma again mapped out by perimetry. By this time patient begins to see in the borders of the blind area, though very indistinctly (Fig. 4).

February 2, 1918: Scotoma again mapped.

February 8, 1918: Condition better, vision improved, scotoma less dense.

February 23, 1918: Scotoma has entirely disappeared, and vision improved a great deal, despite the atropin cyclo-

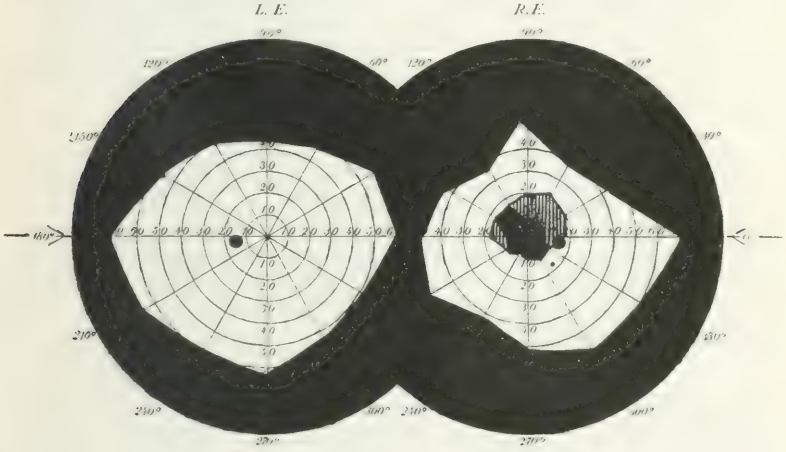


Fig. 4.

plegia. Ophthalmoscopy shows decrease in the swelling and inflammation of the papilla.

March 5, 1918: Although Wassermann is still quadruple plus, all symptoms have disappeared and patient is greatly improved. Discharged to duty.

As compared with practice at home, essential idiopathic migraine was encountered with extreme infrequency.

B. Negative Aspects: It was remarkable, among so many thousands of men, and hundreds of these within the proper age limits, living under such hardships as lack of sleep, exposure, and irregular meals, and subject to so much mental

strain, worry, and anxiety, that glaucoma should have been absent, or practically so, there being but two frank cases, in the author's clinic, for the entire twenty-one months of his incumbency, both of these occurring in very young individuals, each of whom had been affected for many years with the insidious malady.

While there were a few cases of secondary glaucoma from wounds, and such conditions as iridolenticular adhesions, and instances of rise of intraocular tension after necessitated prolonged use of atropin, the rarity of true glaucoma, as noted above, so impressed the writer that he wishes to chronicle the fact and to call the reader's attention to the following interesting case of glaucoma adolescens:

Private T. M. S., aged nineteen years. Infantry. November 25, 1917.

History.—Patient was admitted from Camp Hospital No. 1 with the diagnosis "astigmatism, bilateral." He complained of occasional retrobulbar pains, "as if something were pushing the eyes forward," at which time he noticed blurring of vision and halos appeared at times around a candle-flame or electric light. Stated that his vision was poor and that he could not read for any length of time without tiring his eyes, while at night he experienced extreme difficulty in finding his way about, a condition which handicapped him on two or three night raiding parties, of which he was a member, and during which he was obliged to kill a couple of Boches whom he could otherwise have taken prisoners. Patient had mumps, small-pox, and pneumonia in childhood. Had "intermittent fever" a year ago. Denies venereal history. Previous ocular history negative. Family medical and family ocular histories quite negative also. General health has always been excellent.

Present Condition.—Pupils semi-dilated, react to light, though sluggishly. Anterior chambers shallow. V.R.E., 20/50; L.E., 20/70. Atropin prescribed and patient ordered to return for refraction test.

November 28, 1917: Patient seen for the first time by

the writer, an assistant oculist having conducted the previous tests and prescribed the atropin.

Present Condition.—Patient in a state of atropin cycloplegia, pupils widely dilated, anterior chamber shallow, and tension considerably elevated to palpating finger-tips.

Retinoscopy showed hyperopic astigmatism against the rule, and static refraction tests substantiated this and enabled the vision of each eye to be brought to 20/30. Lenses were prescribed for constant use.

Ophthalmoscopy: There is a marked secondary pressure atrophy of the optic papilla, with extraordinarily deep

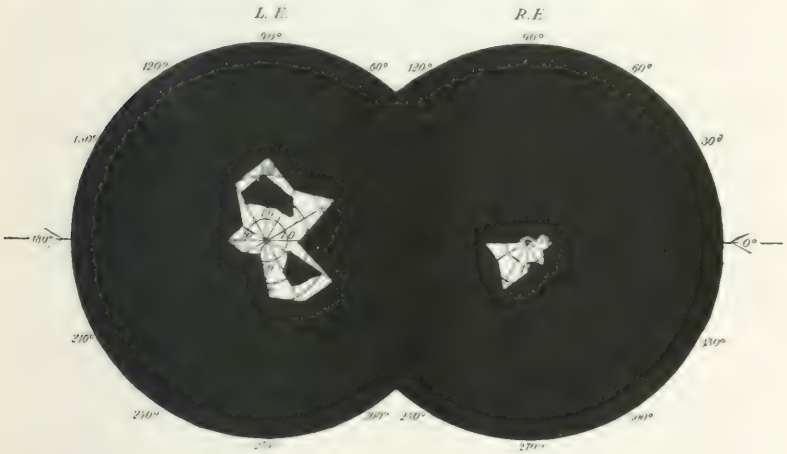


Fig. 5.

total cupping of the disc and undermining of the edges of the same, the retinal vessels disappearing from sight, to reappear again upon the floor of the profound pathologic excavation. Tonometry: Right eye, 50 mm. Hg; left eye, 45. Perimetry (Fig. 5).

Eserin sulphate, 1 per cent., 2 drops in each eye every three hours, was prescribed in an effort to combat the atropin's influence.

Diagnosis of chronic, simple, non-inflammatory glaucoma was made, and operation advised and refused.

December 7, 1917: Wassermann and urinalysis negative. Tonometry: Right eye, 40; left eye, 50 mm. Hg.

January 2, 1918: Tonometry: Right eye, 30; left eye, 35 mm. Hg. Vision with correcting lenses, 20/30 in each eye.

Perimetry: Attention is called to the markedly bizarre and atypical contractions of the visual fields, to the fluctuations in the same, as tested upon different occasions, to the reëntering angles, and especially to the scimitar-shaped or sword-like formations so characteristic of this adolescent, insidious type of glaucoma. It is very odd that, with this amount of restriction of indirect vision, the patient should not have noticed his abnormal ocular state, but he persisted in denying that his vision was noticeably disordered, ex-

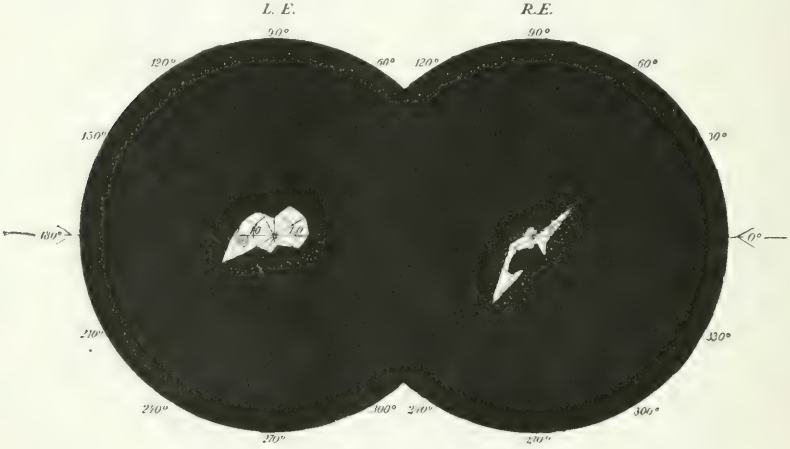


Fig. 6.

cept for the recent difficulty experienced in navigating about "No Man's Land" and raiding enemy trenches at night, probably a difficulty which might beset the most normal of eyes (Fig. 6).

January 8, 1918: Dr. de Schweinitz, who happened to visit the clinic at the time, during his journey through France, was much interested in the case, went over it with the writer, corroborated the diagnosis, remarked upon the rarity of the condition, and advised trephining the right eye as soon as possible. He thought that some members of the boy's family must have had a similar condition (glaucoma adolescens being regarded as a familial thing), and that, being

rather unobservant Arkansas country people, the visual field contraction did not interfere with the ordinary simple chores and hence was unnoted. Certainly this was so with the boy. When the operation was again discussed, the patient still remained obdurate and the examiner then advised that he be brought before the board, reclassified, and shipped home as soon as possible. Indirectly he has since heard that the patient was operated upon in the United States, but, as was to be expected, in view of the hopelessness of the advanced condition, the results were nil.

Idiopathic cataract was observed in but one case, though frequent after penetrating injuries of the anterior segment of the globe and relatively common after direct bulbar blows, while not infrequently detected following a great proximal concussion, as from exploding shells, mines and grenades.

Trachoma, while quite prevalent among the labor battalions, especially the Chinese, was extraordinarily rare among our fighting men, but four cases being recorded by the author at this center, and only one of these a typical acute case, the others being of the familiarly seen atrophic and previously mild variety, such as the following:

Private E. F. F., aged thirty-three years. Field Hospital Attendant. May 22, 1918.

History.—Has had trouble with eyes all his life and has practically been blind in the right eye since infancy. At birth he had an operation performed on the back of his head to which he attributes his eye trouble. At nine years of age an unsuccessful attempt was made to straighten the eye: also had trachoma at this time. At twenty-one years of age he fell and struck the left eye on a chair. Childhood diseases. F.O.H. negative. The physician referring him from the hospital for psychoses says in a letter: "Private F. was admitted to this hospital because of frequent attacks of unsteadiness of the legs, of several months' duration. These attacks are most likely of hysteric origin and have cleared up to a large extent. He gives a history of being practically blind in right eye since childhood and having 20/40 vision in left eye. Nystagmus

since childhood. Said his eye diagnosis was optic atrophy. Blood Wassermann, single plus."

Present Condition.—Slight lateral nystagmus, from the right to the midline. Right eye slightly phthisical, with nebulæ of the cornea and small areas of thinning in the sclera. Superior palpebral conjunctivæ show the white scars of an old trachoma, which observation is borne out by the distortion of the tarsal cartilage and the dry xerotic appearance of the palpebral conjunctivæ, both inferior and superior.

V.R.E., 15/200, eccentric fixation, to the left of object; L.E., 20/70−. Ophthalmoscopy: Negative. Retinoscopy: O.D., sph. −7.00 ⌒ cyl. −1.00 ax. 165°; O.S., sph. +1.50 ⌒ cyl. +.50 ax. 105°.

Diagnosis: Compound myopic astigmatism, O.D., compound hyperopic astigmatism; O.S., trachoma, old; xerosis conjunctivæ.

A chronic conjunctivitis, which, in the slight thickening and distortion of the lids somewhat resembles a trachoma, was noted fairly often, though less frequently than at home, where the workers in factories, crowded stores and offices, so often present similar chronic conjunctival inflammations.

Gonorrheal Ophthalmia.—The relative infrequency of this affection spoke well for the efficacy of the venereal prophylactic measures.

Interstitial Keratitis.—This was rather rare and usually atypical, hence less easily diagnosed as such. Once a typical monocular case due to acquired lues was treated:

Private C. C., aged twenty years. Infantry. March 20, 1918.

History.—Patient complains of the loss of the vision of the right eye for all distant objects, while even nearby things appear dull. On March 8th eyes "mattered" and were a trifle inflamed for a while, but failing vision was not noticed until a day or so ago. In addition, excessive watering of the eyes and sensitiveness to light have been added, the latter more marked in the right than left eye.

Present Condition.—The right pupil is contracted and

irregular; the right cornea is densely infiltrated in the inferior sector; fine, deep, broom-straw blood-vessels are present, and there is slight circumcorneal congestion. The epithelium is intact and fails to stain with fluorescin. There are old, dark scars over the tibiæ, but no general glandular enlargement and none of the stigmata of inherited lues. The knee-jerks are active and the right elbow is stiff.

V.R.E., 20/50; L.E., 20/20. Atropin cycloplegia. Advised Wassermann blood test.

April 6, 1918: Wassermann report: 100 per cent. fixation, specific treatment. Later recovery uneventful.

Diagnosis: Syphilis, secondary, manifested by interstitial keratitis, right, and positive Wassermann.

Keratitis in general was much more common, often traumatic, and mostly seen after exposure to "mustard gas." The severer forms of this gas conjunctivitis were invariably accompanied by a diffuse superficial keratitis or, at least, a few tiny corneal infiltrates or ulcers.

Hordeola and chalazia were not encountered as often as in civil life, doubtless attributable to the lessened use of the eyes for close work and decreased number of cases of asthenopia.

The previous somewhat careful physical examinations had weeded out the cases of keratoconus, irregular astigmatism, and congenital anomalies, so that they were extreme rarities.

Muscular imbalances and refraction errors, producing subjective trouble, were less ordinary, especially the former, no doubt due to lessened near work.

The average number of luetic muscle palsies were seen, and occasionally other incomprehensible instances, such as the following:

Private H. S. B., aged twenty-six years. Engineers. February 28, 1918.

History.—Three weeks ago, after a long hike, he suddenly became aware of a numbness in the left side of the head and deafness in the left ear; since then he has had a dull, left

temporal headache about every other day. Feels weak on entire left side and notices that this side tires first. Complains of dizziness brought on by stooping, but no nausea or vomiting. Denies venereal history. At this time he also discovered that an attempt to look to the left produced lateral homonymous diplopia, without angling or difference in elevation of the two images. When he reported to his regimental physician, a left paralytic convergent strabismus was discovered. Since this time he has had constant, dull, throbbing, frontal headaches. Vision of the right eye has always been superior to that of the left. When a school-boy, was advised, upon numerous occasions, to wear glasses on account of weak eyes. Has been a moderate user of alcohol and tobacco. Family ocular and medical history negative.

Present Condition.—Attempted lateral associated movements of the globes to the left reveal marked lessening in the normal excursive power of the left eye, and the abduction of that eye is so feeble that the patient notes a diplopia almost immediately. The pupils react somewhat sluggishly to the various tests and are slightly miotic. Palpation of the orbital margin reveals no abnormal mass which could mechanically produce restricted abduction. There is moderate deafness in the left ear, a white patch upon the right fauces, and the tonsils are enlarged and injected. There is no marked general glandular enlargement nor visible scar on the penis, but a slight, clear discharge is noted in the meatus urethræ and the right epididymis is thickened and tender.

Nervous system: Deafness, left ear; paralysis of right external rectus muscle; slight weakness of the left arm, slight increase in the reflexes on the left; Babinski, negative; no clonus; Romberg, equivocal.

V.R.E., 20/20 − −; L.E., 20/40 +. Muscles: At 20 feet, esophoria 4°. Ophthalmoscopy: Right eye: Papilloedema, slight, nasal half; Left eye: Papilloedema, slight.

February 25, 1918: Blood and spinal fluid Wassermann, urinalysis, and medical consultation negative.

March 1, 1918: On account of deafness in left ear this ear was syringed for cerumen and found practically clean. During the process the patient became dizzy, and when erect, with eyes closed, showed some tendency to sway forward and to left side, nystagmus also being present at this time.

Aurist's report: Left ear: hearing impaired — — —, whispered voice sounds at a distance of six inches; drum opaque; nose clear; tonsils large and cryptic; adenoids present; advise operation.

March 7, 1918: Under atropin cycloplegia: Ophthalmoscopy: Right eye: Slight hyperemia of the papilla. Pulsation of the inferior temporal vein. Loss in transparency of the walls of the retinal arteries. Left eye: More marked hyperemia of the disc and slight papillo-edema. Retinal arteries rather tortuous and there is a decided loss in transparency of the walls thereof. Ophthalmoscopic impression: Slight retinal arteriosclerosis, suggesting the probability of the same state of the cerebral vessels. Static refraction: O.D., sph.+.50 ⌒ cyl.+.75 ax. 105° = 20/20 — —; O.S., sph. +1.25 ⌒ cyl.+.50 ax. 75° = 20/20 — —.

Diagnosis: Paralysis, abducens, left; arteriosclerosis, retinal, bilateral.

The lid and orbital abscesses, of apparently spontaneous or endogenous origin, were seldom seen as compared with the normal run of hospital clinics, where strumous children seem to be the preponderating type of victims.

Sympathetic ophthalmia, despite numerous precise cases of sympathetic irritation, was neither observed in this center nor heard of from the clinics of colleagues in the United States army. Thirty cases have been reported among the French casualties and even more have been cited in the German literature.

Despite enormous vitreous hemorrhages, the adventitious blood-vessel formation, so often noted in those spontaneous hemorrhages thought to be associated with a tuberculous diathesis, was rarely observed, the absorption usually being complete.

Toxic amblyopia, considering the volume of bad liquor consumed and the inordinate number of cigarettes smoked, was most infrequently seen, as was the amblyopia from loss of blood.

How War Ophthalmic Surgery Differs from Civil and from General War Surgery

The greatest point of variation lies in the fact that one usually operates in a field that has been thoroughly and virulently infected, the process usually being some days advanced by the time it reaches interference. This complicated matters not a little, and the most important of sutures will frequently slough out, so that several operations are often required before the desired approximation of parts is achieved.

Furthermore, the tissues are far more severely traumatized than one ordinarily sees in industrial accidents, and the relations so disturbed that it is ordinarily impossible to follow any definite, previously outlined procedure, each case being a "rule unto itself" and presenting unique problems, which, as the operation advances, tax the surgeon's ingenuity not a little.

Again, one is obliged to dispense with a routine procedure, as in civil surgery, pursuing an entirely different course in almost every case, depending upon the special exigencies that arise.

The ophthalmic indications are sometimes quite contrary to the surgical and often seem quite incomprehensible to the general men who fail to recognize that the oculist has to achieve more than a mere surgical success to prevent his work from being a physiologic failure.

For example, in general war surgery a thorough and extensive débridement is indicated, much skin, muscle and other tissue being removed about the wound, whereas in wounds of the eyelids and adjacent parts such débridement is seldom necessary and cannot be performed, save in a most sparing way, it being of the greatest importance for the proper functioning of the eye, in view of its special relations, that every effort be made to save tissue in wounds involving it or

its adnexa. Primary repair of almost all these wounds should be attempted, even when infection is plainly present, because this will obviate the necessity of much secondary plastic work. In very extensive wounds it may be necessary to insert a small drain in one corner. Special attention is called to the necessity of early and accurate repair of wounds of the lower lid, with particular reference to those involving the inner portion. Obviously, a very slight loss of skin is difficult, if not impossible, to remedy in such a manner as to be compatible with cosmetic, functional, or protective results.

In orbital wounds the tissues should be conserved, especially in doing enucleations and eviscerations. An orbit should never be packed, but when a definite cellulitis exists, a small drain is often advisable. An evisceration leaves a very good stump, and frequently this is the procedure selected for a ruptured or collapsed ball and for panophthalmitis. It should be the operation of choice where a good clean enucleation with implantation of fat or lead-free glass sphere is impracticable.

The plastic work upon the eyelids has been somewhat out of the ordinary civil routine. In many of the cases the condition is complicated by defects of the orbital margins and of the fleshy and bony structures of the face. Much progress has been made during the war in the rectification of these faciomaxillary losses. Each case really needs special, individual study and often taxes the originality and skill of the most highly trained men. The writer was more impressed with the results of the French ophthalmic surgeons along these lines than of our other allied colleagues.

In penetrating wounds of the globe giant strides have been made in the general adoption, by ophthalmic surgeons, of the conjunctival flap operation. After one has excised the prolapsed structures and freed the wound of any intraocular tissues, the bulbar conjunctiva nearest the site of entrance is

undermined and drawn over the same, often across the entire cornea, and then stitched in place. These sutures yield in three or four days and the conjunctiva slips back to its former place, but in the meantime the delicate intraocular structures have been sealed off by a plug of plastic exudate, infection or prolapse prevented, and the situation thereby often saved, the corneal wound usually having healed perfectly and uneventfully.

Another difference is that many operations of a reuniting and plastic nature are usually required before gratifying results are obtained, in contradistinction to civil surgery, where, without infection, trauma, and so forth, one or two usually suffice. For example: an enucleation usually means a minute search for torn, twisted, and intermingled shreds of choroid, sclera, conjunctiva and muscles, in order to effect a complete removal of the globe. Then a conjunctivoplasty and often a double blepharoplasty as well are necessary. Perhaps the adjacent sinuses are involved, the whole being infected, when extensive cleaning up, débridement, and drainage must be instituted. Lister developed a very pretty operation for the removal of panophthalmitic eyes, which, theoretically, insured against the opening of the optic nerve's intervaginal space to possible meningeal infection. It was dubbed the "scleral frill operation," and consisted of thorough evisceration, followed by removal of all the sclera up to within three or four millimeters of the nerve, which frill and nerve, like a tiny white mushroom, was left *in situ*.

For satisfactory cosmetic results Frost's operation was advised in our own army, but in the experience of the author and those associated with him the tightly sutured-in glass sphere produced tremendous mechanical reaction, for usually infection was present, drainage insufficient, and the sutures soon yielded or sinuses formed elsewhere and the glass ball was extruded. Also, cartilage cubes and masses of fat

from the subcutaneous abdominal region were implanted or transplanted in order to furnish more convexity to the prosthetic bed. By far the most satisfactory procedure was the ordinary enucleation with suturing of all four recti muscles, and a purse-string of the orifice of the bulbar conjunctiva, with or without a horse-hair drain.

The great loss of bulbar conjunctiva was ever a problem, and because of the contracted conjunctival culdesac, necessitated many subsequent plastic operations, such as splitting the palpebral conjunctiva at the fornix and sliding the flap posteriorly, or grafting mucous membrane, the latter holding in place with dilators, while the actual stretching process alone was sometimes successful. This could be carried out with ordinary aluminum or vulcanized-rubber convex discs, made to suit the shape of the socket, from a previous paraffin cast, and gradually increased in size until sufficient stretching was obtained, or, better still, the cleverly conceived Ombredanne's discs, which, by anterior attachment to an upright metal band, superiorly and inferiorly affixed by adhesive strips to the frontal and malar areas respectively, were thus held away from exercising pressure posteriorly upon the bulbar bed, only stretching the fornices laterally and the lids anteriorly. Some of the British oculists, indeed, prescribed vulcanized prosthetic devices in the socket under the artificial eyes for constant use after everything was healed and finished, claiming greater mobility and a less sunken appearance in consequence.

When extreme damage had been done to the lids and the loss of blepharal tissue was practically complete, sliding flaps usually secured a fair result, supplemented by grafting to fill out the destroyed socket. The author's personal experience with the latter has been limited, such cases being done further back.

Many times there were brought back cases in which, usually from a laterally striking sniper's bullet, the lids,

entire globe, and adnexa had been swept away, orbit shattered, nasal bone destroyed, sinuses opened, and the whole foully infected. At first, in these hopeless cases, it was very difficult to keep the wounds clean, and sutures simply would not hold in the yielding, infiltrated, necrosing, phlegmonous tissues which were left. However, after cleaning up with forceps and scissors, and then spraying thoroughly with dichloramin T, rapid and gratifying results were obtained. Later, when entirely clean, plastic procedures could be safely resorted to.

"War is Hell!" without a doubt, but "it's an ill wind that blows nobody good" is an adage equally true, and the science of medicine has benefited greatly during these wonderful years of practical human research, harrowing as it has been. The progress of ophthalmology seems to have been particularly along lines destined to expedite and facilitate the proper handling of industrial accidents and the safeguarding of the eyes of people en masse, labor colonies, schools, asylums, and prisons.

As an example of the development of the so-called "eye centers" in the American Expeditionary Forces may be quoted the history of the eye department of the Johns Hopkins Base Hospital Unit, with the details of which particular organization the author, as its surgeon, is most familiar:

HISTORY OF THE EYE DEPARTMENT OF BASE HOSPITAL NO. 18.—While occasional minor ocular maladies presented themselves for treatment, no actual eye clinic was organized until the unit's arrival at Bazoilles. In this connection it may be of interest to note that an eye case was the first to be admitted to Base Hospital No. 18, being an acute, monocular pemphigus conjunctivæ.

In the summer of 1917, owing to the lack of proper space for an eye clinic, and pending the construction of the dispensary building, that of the well-equipped French base

hospital, Rebeval Barracks, at Neufchateau, was placed at the disposal of the writer through the courtesy of the Medicin-Chef and the Oculiste. By composing a schedule which did not interfere with that of the French physicians advantage was taken of this happy arrangement, and patients needing refraction were daily transported in ambulances, thither and back, for their tests, though inflammatory treatments were conducted in our own wards and operations performed in our own surgical amphitheater from the outset.

Later, when the dispensary building was completed, a combined refraction and waiting room, $22\frac{1}{2}' \times 8\frac{1}{2}'$, and a dark room, $5\frac{1}{2}' \times 4\frac{1}{2}'$, soon proved all too small for the adequate handling of the work and the comfort of the two oculists employed therein. During all this time, while the results with inflammatory cases were eminently satisfactory, the refraction cases were obliged to order their lenses by mail, from private concerns in Paris, and at least six weeks were thus lost in the delivery of the lenses. Moreover, officers and men of constantly moving units often entirely failed to receive their frequently reforwarded spectacles. In the spring of 1918 this situation was partially remedied: first, by the addition of two more rooms, one $22\frac{1}{2}' \times 9\frac{1}{2}'$, equipped for two more refractionists, as well as for special examinations, such as perimetry, the other, $14' \times 12\frac{1}{2}'$, to house the Optical Unit; secondly, by the presence of this new unit. This latter organization consisted of a team of skilled opticians, sent from a group especially selected and mobilized in the United States, and supplied with quite a complete stock of lenses of various strengths and a uniform size to fit a standard spectacle-frame, all being issued gratis to the patient, while a full set of appliances and tools for adjustments and repairs were included. Thus it was possible for patients to have the finished product handed them within ten minutes of the completion of their refraction tests. In these quarters

it was possible for three physicians to work with comfort, and at one time four did carry on the work with reasonable satisfaction. But the clinic, drawing work from 21 base, 13 evacuation, 10 field, and 5 camp hospitals, besides 3 convalescent camps and 33 other large miscellaneous military organizations in the sector, and being the most advanced of the eye centers in France, grew by leaps and bounds so that it soon became necessary to move from the again cramped and insufficient quarters.

In the autumn of 1918 adjoining hospital barracks were put at our disposal, and herein was constructed a large and ideally arranged eye center:

(*a*) Dispensary building: 1. Waiting room, 31′ x 11′.

2. Main refraction room, 22′ x 18½′.

This room was equipped with four testing booths, the latter painted black and provided with heavy black curtains, so that the dark-room tests, such as oblique illumination, pupillary reactions, retinoscopy, and ophthalmoscopy, could be conducted therein, and without moving patients and losing time, the curtains could be drawn aside and the distant refraction or muscle tests immediately carried on to completion, the latter two being controlled by individual electric switches directly at the examiner's hand. In this manner four oculists could be continuously employed at the same time and a volume of refraction work thoroughly and expeditiously handled, each booth containing complete equipment. As a further aid, two clerks' desks were attached to each of the side walls and the examiner's dictation was jotted down on the histories by a trained amanuensis as the tests progressed, again saving much time.

3. Optician's room, 12′ x 10′.

From here the patient entered one of two doors, standing side by side at the end of the room: one to the inflammatory room, the other to the optical department. In the latter were six trained opticians continuously employed in the

making, mounting, adjusting, or repairing of spectacles. Here were well-fitted benches, shelves, and cabinets, and a goodly stock of lenses and frames, while a clerk took charge of the mail orders and typed the optical correspondence.

4. Inflammatory room, 9½′ x 5½′.

Contained electric sterilizer, instrument and medicine cabinet, table, chair for minor operations and other apparatus, and here the lesser medical and surgical treatments were conducted.

5. Special testing room, 9½′ x 5½′.

In this room perimetric and scotometric studies were conducted, and exceptionally nervous or ill cases examined, where, owing to the privacy, better results could be achieved.

6. Private history-taking and refraction room, fully equipped for two patients, for officers and nurses, 22½′ x 8½′, with adjacent dark room, 5½′ x 4½′.

7. Eye operating room.

This was an excellently arranged room, 15½′ x 9½′, containing all necessary equipment for any eye operation, and was unusually well lighted by two windows at one end of the room. In this connection it may be of especial interest to speak of the presence and constant employment of electromagnets of three sizes—one so-called "Giant," one medium sized, and one very small. The operators working with these magnets in this eye center have secured gratifying results in the removal of intraocular, magnetizable foreign bodies.

(*b*) Eye ward, 160′ x 20′.

This ward contained fifty beds and six small rooms besides, each measuring 9½′ x 7′, and used for ward office, wash room, dressing room, supply room, and kitchen. All cases here were solely ophthalmic ones, and there were always many eye cases, having other wounds or injuries, in the other surgical and medical wards, while all officer eye patients were kept on the officers' general wards.

Before proceeding further it would seem well to mention the exceptional value, in the diagnosing of the rarer clinical conditions, of the proximity and close coöperation of the *x*-ray and the laboratory, besides emphasizing the general and special medical and surgical consultations, which were always right at hand. The writer believes that it has made feasible the study and reporting of many exceptional cases, which must otherwise, and in routine civil practice, have been impossible. This and the facility of securing the Surgeon General's records of cases and following up patients have been the means of shedding much light upon many ocular conditions which have, in the literature obtainable in times past, as well as in the writer's experience, been obscure in both etiology and clinical progress.

Prior to the writer's leaving France the clinic had been built up to quite a respectable point, viewed purely from the angle of the volume of work done. The dispensary was treating between 50 and 70 patients a day, and the eye ward was well filled and overflowing into other wards, while the optical department received close to 1500 prescriptions for glasses monthly.

Before closing the description of this eye department the writer wishes to acknowledge the invaluable assistance of the energetic and highly trained Red Cross worker assigned to the center for the amusement and education of the convalescent blind, those with prospects of blindness or diminution in visual power, or those with temporary impairment or loss of sight.

She has written upon her duties as follows:

"I shall attempt briefly to give you an idea of what we are trying to do to help the blind boys before they arrive home.

"In the majority of cases, when a man learns that he is to go through life without seeing, the first thought is to end it all. He believes that, as he cannot see, there is nothing he can do, consequently he does not wish to go through life a

burden to others. The first lesson teaches him to wait upon himself; to walk about unaided, both indoors and in the open, to dress, to shave, and to care for his personal toilet and hygiene. As soon as he learns that he can do these things, he again takes some interest in life. It is at this stage that his sense of touch is developed. This is done gradually. He is given puzzles with which to amuse himself, and begins by taking them apart and putting them together again. Without realizing it, he becomes interested and his sense of touch grows keener. Day by day he discovers that he can accomplish things which, a short time before, he thought impossible. Having friends to whom he wishes to write, he is given a pencil, paper, and a grooved cardboard, and thus composes and executes his first letter, the cardboard serving as a line guide. Later, of course, he is taught an elevated type, usually Braille, which he can read and write. Moreover, he is encouraged to play various games, for example, checkers (a special board being used for this), dominoes, cards (played with an embossed deck), and many others. A watch is given him, and he learns to tell the time by touch, which usually pleases him greatly. Instruction is received in the making of hammocks, basket weaving, rake knitting, manufacture of brushes, bead work, and a score of other similar occupations, or he is encouraged in any more esthetic line in which he may be interested, as music, art, sculpture, molding, wood carving, etc. He is also given lessons in shorthand and stenography and is taught a touch system which may be used on any standard typewriter.

"Almost all instruction is individual, and the progress made depends largely on the person himself. The method of teaching varies slightly according to the nature of the man, his previous education, environment, occupation, and so forth. Each new thing must be taken gradually and never pushed too much. Some of the men take the opportunity of learning everything possible, while others, being in a weaker physical condition or feebler frame of mind, will absorb only certain things. When a patient has but one hand he can specialize on particular accomplishments. All things favorable, the men are usually encouraged to continue the same general line of work they pursued prior to being

blinded. Where this is impossible, they are taught some other special sort of occupation, selected, when feasible, from consideration of their own personal preferences.

"The entire secret of the success of a blind man is work, and experience has given us workers among the blind the following motto: 'Help the blind to help themselves.' This can be done only by giving them plenty of work."

The advantages of this splendid system are only too apparent. The worst time in a blinded or partially blinded man's life is the first week or month of convalescence, and the despair, generated by the realization of his blighted vision, is to some well-nigh unbearable. This is the time to strike, and if he can be amused, given hope of self-support, have his ability to do things demonstrated, started upon the groundwork of his future education during the tedious days of his hospitalization, before his cosmos has become sombre and his outlook one of perverted pessimism, an extremely useful citizen may be salvaged from the tragic wreck.

NOTES ON VERNAL CONJUNCTIVITIS.*

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Perhaps no better introduction to a discussion of vernal conjunctivitis can be found than the following paragraph from Axenfeld's[1] comprehensive report to the Société Française d'Ophtalmologie in March, 1907: "But the pathogenesis having remained obscure, the treatment largely inefficacious, the pathologic anatomy disputed on important points, it shall be our duty in this report to show what progress we have made in these latter years, which questions remain to be clarified, and how the researches of the future must be directed to lead us in the end to an interpretation of this disease, which is one of the most distinctive and yet one of the most strange in the entire range of pathology."

These words serve well even today to define the attitude of ophthalmologists toward vernal conjunctivitis. Duane's edition (fifth American) of Fuchs' Textbook of Ophthalmology[2] reads as follows: "The prognosis is therefore good as regards the ultimate outcome, but bad as regards the duration, as up to the present time we know of no remedy for curing the disease or for preventing its annual return. The cause of the disease is unknown."

Vernal "conjunctivitis," as de Schweinitz[3] very properly insists it should be named, instead of "catarrh," though relatively rare, is an unusually interesting clinical entity. Its literature has become quite extensive. Axenfeld[1] appended 135 references to his report. That number could easily be increased now to more than 200. In this connection

*Candidate's thesis for Membership accepted by the Committee on Theses.

only a consideration of some salient points of etiologic, pathologic, or therapeutic significance will be attempted, with a few case reports outlining a simple and apparently efficacious method of treatment.

ETIOLOGIC FACTORS.—(*a*) *Heat.*—Haab[4] states that this disease is of special interest because, with the exception of malaria, it is the only one affecting the human body entirely dependent on "heat," so that in cool summer seasons it really does not develop. The persistent and regular return of the symptoms coincident with the advent of warm weather in spring or summer is the one fact upon which a diagnosis may be based with absolute assurance in connection with the clinical manifestations of this disease. While heat may be the immediate exciting factor, it cannot be the sole cause. Only a small fraction of all eye patients have vernal conjunctivitis. The greatest frequency, reported by Trantas[5] (Constantinople), is about 1 per cent. of all patients, indicating that only a very small fraction of the general population is thus afflicted. Nearly all patients eventually attain to a recovery spontaneously, after which the inexorable return of summer heat fails to develop the characteristic ocular symptoms. That the recurrence is determined by heat rather than by habit is evident from the experience of a young Argentinian, observed by Morax,[6] who for more than ten years had annual attacks at Buenos Aires in November, December, and January. He came to Europe in October, 1904, and had no trouble until the following June, when the disease returned with marked severity.

(*b*) *Climate.*—The influence of climate may be exerted on the conjunctival sac through desiccation, wind, and dust, or by sunlight alone. Preponderance of evidence seems to justify the statement that where dry heat prevails, vernal conjunctivitis is more prevalent than where the spring and summer seasons are associated with great humidity.

Bartels[7] stated that the rarity of vernal conjunctivitis in

Lima and its frequent occurrence in southern Peru tend to confirm hot, dry, dusty air as a cause. Herbert[8] saw 39 cases in Bombay in two and a half years, but the discussion of his paper showed that the disease is rare in England, where a relatively high degree of humidity prevails. Jackson[9] reports 44 cases collected in Denver during fifteen years, and adds that "ten years' previous acquaintance with the disease in Philadelphia seems to indicate that it is more common in the dry elevated region of the western United States." Feingold[10] states that "if unusual heat were to be the cause, New Orleans, with its long summer, should show a great deal of vernal conjunctivitis, but that it is characteristic of our city that no vernal conjunctivitis is seen, or only in abortive cases." This apparent contradiction is in a large measure explained by the following additional statements[11] concerning the climate of New Orleans: "The precipitation exceeds 60 inches, New Orleans shows a maximum during June, July, August. The sky is clouded 50 per cent. of the winter season and 40 per cent. of the summer." Thus the great humidity and frequent relief from dusty winds by copious rainfall so modify the usual effect of unchecked heat and dryness that Feingold's report is not unusual. Hosch[12] found that the conjunctivitis of springtime did not develop until summer if the former season were cool and moist, and that prolonged rains in summer produced temporary relief. The reports of Saemisch, Schmeichler, Fuchs, Nils, Remmen, and Webster Fox are quoted by Axenfeld[1] as confirming the etiologic importance of heat and drought. Danvers[13] reports on records of 50 cases of vernal conjunctivitis, collected at Parma, in his thesis for the Italian diploma of medicine. He seemed to find that humidity increased the frequency. In Italy the greatest rainfall occurs in fall and winter, the summers being so dry that the small river-beds become dry and irrigation is often needed to insure crops. It is hardly possible, therefore, to compare the occasional relative humid-

ity during the dry summer season in Italy with other sections where the percentage of humidity is both high and constant. Given a dry and dust-laden atmosphere, it is to be expected that exposure to strong wind will increase their irritant effect on the conjunctiva. The more frequent and prolonged exposure out-of-doors may account for the greater frequency of vernal conjunctivitis among the rural population, as noted by Weeks[14] and also by Danvers,[13] 33 of whose 50 cases were from the country. Besides, in most cities more or less efficient methods are in use to lay the dust.

Bayer's experiments with transparent occlusive dressings seem to exclude any pathogenic effect of light *per se*. Feingold[10] confirms this report by his own tests. Axenfeld presents the following tabulation reported by Widmark, Sweden, which tends to show that the prolonged illumination during summer in the higher latitudes is not an exciting cause.

	Latitude Degrees	Longest Day, Hours	Average Temperature Degrees Fahrenheit	
			June	Annual
Haparanda (one case)	66.0	22½	53.0	32.5
Hernoesand (none in ten years)	62.0	20	54.5	38.0
Gefle (one in 5000—four years)	60.5	18½	56.4	40.0
Stockholm (58—53402—fourteen years)	59.5	17½	57.2	41.5
Lund (3 in 5600)	56.0	15½	61.5	45.0

(*c*) *Microörganisms.*—According to Weeks[14] and Kalt,[15] a good argument may be made for the bacterial origin of vernal conjunctivitis. Axenfeld[1] finds no reason to affirm bacterial origin, but says the possibility cannot be denied without further research.

(*d*) *Predisposition.*—No matter what theory is advanced to explain vernal conjunctivitis, it is impossible to deny that individual susceptibility varies greatly, even among those afflicted with the disease. Both general health and local conditions must be considered in this connection. Its spon-

taneous cure after an uncertain period and occasional relapses also indicate that the immunity is not constant.

Some patients show changes at the limbus only, giving rise to the name "perikerato conjunctivitis exuberans," applied by Carmone y Valle,[16] Mexico. In others the typical alterations in the tarsal conjunctiva predominate. Many show a combination of these, but of variable severity. In some even that very unique and almost constant objective clinical sign of the disease, the "bluish milky" surface reflex, is missing. Jackson[9] found it present in only 17 of his 44 cases. The diagnosis is then dependent on a regularly recurring, rather localized, and characteristic congestion of the ocular conjunctiva, with itching and mild photophobia.

These variations seem not to be limited by locality or climate. Conclusions based on any one series may be misleading. Larger numbers and longer periods give more nearly uniform results. Ahlström,[17] in a collection of 96 cases, found 50 per cent. were of the palpebral, 24 per cent. of the ocular, and 26 per cent. of the mixed type. Saemisch[18] found the mixed type much more abundant than either the purely palpebral or bulbar varieties. Trantas[5] reported 75 per cent. of mixed type. Stark[19] stated that the palpebral type was not seen at El Paso, Texas. Recent reports by Gonzalez[20] and Fernandez[21] indicate that both bulbar and palpebral types are to be found in Mexico and Cuba.

The greater number of sufferers from vernal conjunctivitis belong to the male sex. Saemisch[18] reported that 79 per cent. of his 185 cases were males. Trantas,[22] of Constantinople, reports 90 per cent. males, and refers to the possibility that the greater frequency among Turkish men is due to their wearing of the fez, which affords no protection for the eyes. Edward Jackson[9] reports 57 per cent. males, and states that the preponderance might be easily accounted for by more general exposure to light and dust.

The disease usually begins between the sixth and twentieth

years of life, although exceptional cases are reported beginning earlier or later. Jackson saw one case beginning in a woman seventy-five years of age and recurring for three successive summers. The average duration is placed by Saemisch[18] at four to six years, but Gasparrini[23] reports histologic studies of an eye of a patient sixty-four years of age who had suffered from the disease for fifty-two years.

Race and consanguinity seem to be negligible factors so far as vernal conjunctivitis is concerned. Morax[6] and Fuchs[24] report instances where two children of the same family were afflicted, while other children showed no ocular disturbance. Angellucci[25] and Wechsler[26] each saw a child with vernal conjunctivitis where a parent had previously suffered from the same disease. An additional case is reported by the writer in this series.

Careful studies of the general health have failed to reveal any condition sufficiently constant to be directly associated with individual susceptibility. For example, Axenfeld[1] quoted reports of general lymphocytosis which coincided with his own investigations. His view was indorsed in subsequent discussions by Gallemaerts,[27] Brussels, who had noted an increase of eosinophile lymphocytes, but was directly contrary to the results of tests reported by de Lapersonne,[28] where the blood was found absolutely normal on repeated examination. More recently Butler[29] reports a slight but constant eosinophilia in the blood of patients.

The same incompatibility of evidence seems to pertain to anemia and other general nutritional changes. Botterri[30] states that all patients were strong peasants and showed marked pigmentation, while Schleich[31] reports low nutrition and anemia constant. von Michel[32] at one time insisted that the underlying malady must be one involving the entire system of lymphatic ganglia, therefore hereditary lues must be considered. Equally futile have been attempts to estab-

lish any relation between vernal conjunctivitis and general or local tuberculosis.

Boé[33] regrets that the disease is not serious enough to permit studies on the effect of transfusion of blood between susceptible persons, etc. He refers to a case where an attack of puerperal fever suddenly and totally eliminated vernal conjunctivitis.

Local or general skin diseases, diseases of the nose, hayfever, or other types of conjunctivitis may be coexistent, but have shown no constant etiologic relation to vernal conjunctivitis.

(*e*) *Location.*—Vernal conjunctivitis is strictly a local disease. Its most typical alterations involve the conjunctiva on the tarsus or at the corneal limbus or both. General congestion of the ocular conjunctiva, when present, is secondary to the intense itching and photophobia. Often the ocular congestion is localized about one or several points of the limbus in such a way that this disease was designated as "phlyctæna pallida" by von Graefe.[34]

Why is it thus localized? It is possible that some reason may be found which might assist in a better understanding of the etiology. The significant fact that these are the portions of the conjunctival sac where the conjunctiva is *firmly attached to its base* has apparently not received the attention it deserves. The conjunctiva of the fornix and the ocular (bulbar) conjunctiva throughout, except at the limbus, where its epithelium merges with that of the cornea, is freely movable over the underlying connective tissue, and is actually kept in motion, except during sleep, by incessant movements of the globe and lids. Such mobility means increased circulation both in the blood-vessels and the lymphatics. This in turn means better local nutrition and the more efficient elimination of waste products.

According to Koeppe,[35] the episcleral blood-vessels are well supplied with lymphatics, even the finest capillaries being

surrounded by relatively large spaces. These include the capillary loops at the limbus, but contrary to the theory of von Recklinghausen,[36] they do not anastomose with the corneal lymph-spaces. The flow of lymph, therefore, is probably somewhat sluggish at this fixed terminus of true conjunctival tissue, which Morax[37] calls "une portion intercalaire."

That the circulation of the scleral and ciliary vessels at the limbus is more vigorous at this point than that of the conjunctival vessels is indicated by the fact that in conjunctival inflammations the congestion at the limbus is usually less than at any other zone of the ocular conjunctiva, while the reverse is true with ciliary congestion. The recent examination of the eyes of a soldier burned August, 1918, with mustard gas showed that the cicatricial zone of 2 to 3 mm. in width, surrounding the cornea, was supplied by new vessels branching from the deep ciliary vessels at the limbus, while the network of conjunctival vessels stopped at the outer margin of this zone at a sharp line of demarcation. Furthermore, there would appear to be no chance for either blood or lymph to flow as freely in the tarsal conjunctiva, closely adherent to a firm fibrous base, as in any other part of the conjunctival area.

The notable epithelial proliferations of vernal conjunctivitis occur at the limbus, where the stratified columnar epithelium of the conjunctival sac has been converted into the stratified squamous type to merge with the epithelial covering of the cornea. The papillary hyperplasia of connective tissue with hyaline degeneration occurs in the palpebral conjunctiva covered by the usual stratified columnar epithelium, which seems to be but slightly disturbed by the process. The narrow band of smooth squamous epithelium at the lid margin, where it merges with the skin, apparently forms the boundary for the changes incident to vernal conjunctivitis, as it does for trachoma (Ball).[38]

Normally there is considerable evaporation from the conjunctival surface. The loss is supplied by moisture secreted by the mucous membrane, and only after exceptional irritation are tears supplied by the lacrimal gland. In the presence of greater heat and dryness, especially if there is any failure in the conjunctival secretory function, the parts likely to suffer first are those where the subconjunctival circulation is least elastic—probably at the fixed points, as above noted. Though the greatest direct loss is from the ocular surface, the movement of the eyelids distributes this loss rather uniformly over the tarsal conjunctiva as well. Probably most of the moisture for the surface of the cornea is normally supplied by the conjunctiva on the superior tarsus.

The first effect would thus be exerted on the epithelium, but the subepithelial reaction would be almost simultaneous. The question of priority among these changes has caused much discussion. Vetsch,[39] among the earliest to undertake histologic study of the disease, concluded that the epithelial proliferation is the primary and most important pathologic change in the tissue. Axenfeld[1] believes that the inflammatory reaction develops in the conjunctival connective tissue and that the epithelial proliferations are secondary changes. According to Schieck,[40] tissue proliferation and hyaline degeneration play the principal rôle, not merely in the conjunctiva proper, but in the underlying tarsal or episcleral tissues. Cellular infiltration seems to be entirely secondary. Kalt[15] and Ginsberg[41] point out that opportunity to study early cases alone can answer this question.

Adams[42] notes that in vernal conjunctivitis "there is very slight mucoid change," while in trachoma and follicular conjunctivitis mucoid changes are extensive. This modification of epithelial function may bear some relation to the intense itching through irritation of the nerve-endings by the changed composition of the secretion.

As Chaillous[43] points out, itching probably precedes all other manifestations. In some cases structural changes are so slight that only the ocular congestion and itching indicate the return of the disease with each spring or summer season. Perhaps the earliest structural change is drying of the superficial epithelial cells, provoking cell proliferation and extension downward as a natural reaction for protection against further drying. The most superficial cells may become homogeneous and lose their nuclear staining, thus simulating in appearance if not in actual change of substance the keratin lamellæ of the skin (Ginsberg[41]).

The special conjunctival nerve-endings, Krause's corpuscles, differ from the Pacinian corpuscles of the skin by the absence of a thick, laminated investment. They may be unusually sensitive to chemical irritants liberated by the effect of heat and dryness on the epithelium. The chemical changes incident to the loss of water, in the presence of sensitizing enzymes, may cause these cells to become the irritant factor provoking the tissue reactions which have been noted.

The itching and subsequent rubbing of the eyelids may inoculate these dried cells into the sensitized tissue, producing locally the reaction of an anaphylatoxin. Leukopenia and eosinophilia are noted as general effects of anaphylactic toxin (Wells[44]). Such a local reaction might be assumed from the abundance of eosinophiles and the slight local lymphocytosis in vernal conjunctivitis as compared with trachoma, follicular catarrh, etc. The tissue reaction could be explained in this way without recourse to a specific bacterial infection. According to Pereyra,[45] eosinophiles are present in various types of conjunctival inflammations and are constant in "provoked" conjunctivitis from drugs or superficial caustics.

If the itching were present only where hyaline deposits are found, chemical or mechanical irritation from that source might be to blame. On the other hand, the subjective dis-

comfort ceases with cool or damp weather, but the hyaline deposits often show but little change between seasons. Hence it seems unlikely that they are concerned in producing these symptoms.

Practically at the same time a subepithelial hyperplasia of connective tissue ensues. If this pushes upward between these epithelial invaginations, nodules are formed. These differ from the lymphoid granulations of trachoma by containing relatively few lymphocytes, but a marked predominance of connective-tissue cells with more or less hyaline degeneration. The thin layer of hyaline degeneration may extend quite uniformly throughout the conjunctival sac (equals degenerative changes of the ground substance fibers and interfibrillary exudates), producing the "bluish-milky" or opalescent reflex. Relatively few blood-vessels are found in this new hyperplastic tissue and its products.

The presence of hyalin is so constant that it appears to be another phase of nature's defense against the irritant agent or organism producing this disease. According to H. G. Wells,[44] "there is no one chemical compound 'hyalin' which, accumulating in cells or tissues, produces a hyaline appearance." He describes a form of hyalin observed in scar tissue which develops after the blood supply has been reduced to a minimum, and states that presumably it is "similar in nature to the collagen of normal fibrous tissue intercellular substance which has undergone physical rather than chemical changes into a homogeneous hyaline substance. It has for its physiologic prototype the thick 'collagenous' fibers of the subcutaneous connective tissue."

Axenfeld[46] suggests that the characteristic "bluish-milky" reflex of vernal conjunctivitis is due chiefly to the subepithelial homogeneous sclerosis of proliferated connective tissue, but states that epithelial thickening may have a part in it. According to Stoehr,[47] the superficial cells of the

stratified columnar epithelium normally show a thin hyaline cuticular seam.

If we attempt to generalize from these reports, it would appear that the deviations in the histologic structures of the conjunctiva tend to approach the epidermal structure both by the pseudokeratinization of the epithelium and by the formation of hyalin in subepithelial connective tissue. These changes do not occur where the vascular and lymphatic circulation is unusually abundant, nor in the fornices, where the drying-out process is prevented primarily by the lack of exposure.

This analogy is masked through a number of secondary developments. Unusual large masses of epithelial proliferation with cystic degeneration (Antonelli[48]) at the limbus are reported. Large localized relapsing nodules of connective tissue develop in the tarsal conjunctiva which do not fit into this general picture of temporary epidermization of the conjunctiva in vernal conjunctivitis. However, once the provocation for connective tissue or epithelial proliferation has been supplied, it is not impossible for the special local developments which have been reported in connection with this disease to occur. A long-standing relapsing process need not conform to the original typical defensive process incident to summer heat and dryness.

During the fall and winter season the conjunctival tissues usually manifest a strong tendency to return to normal through absorption of necrotic tissues and through the regular development of connective-tissue cells into normal fibrous structure. In the torrid zone, according to Gonzalez[20] and Fernandez,[21] the difference in temperature is so slight that the return to normal is practically never accomplished, though the acute symptoms disappear. Parsons[49] also reports that his observations indicate but little change due to change of season.

THERAPEUTIC MEASURES.—A simple and certain method

of securing relief from the annoying symptoms of vernal conjunctivitis noted by Axenfeld[1] was the occlusive dressing. As above noted, it was not found necessary to exclude both light and air. A transparent covering for the eyes was sufficient to obtain much relief, but the symptoms returned whenever the dressing was discontinued in warm weather. These limitations hardly make of it a practical or popular remedy.

A large number of reports in recent years indicate that, if properly applied, *x*-rays or radium will produce marked amelioration of the discomfort, prevent relapses, and apparently cure vernal conjunctivitis.

The experiences of Allport,[50] Pusey,[51] Butler,[29] and Shumway[52] are convincing on this point. Radium is more popular than *x*-rays. Sufficient experience has apparently been accumulated to permit an accurate estimate of the proper dosage of radium with entire freedom from harmful effects.

According to Wells,[53] *x*-rays stimulate cell growth when applied in small amounts, but larger amounts produce necrosis. Immature cells and cells in active division are more sensitive than adult cells. Radium shares with *x*-rays the power of causing tissue necrosis and produces general lymphocytosis after prolonged exposure. They both have marked effect on metabolism, and radium seems to stimulate the action of most enzymes. The favorable effect of *x*-rays and radium may be explained probably by their effect on local metabolism, rather than by any bactericidal power. According to McCallum,[54] "Roentgen rays have little injurious effect upon bacteria, but the 'Alpha' and 'Beta' rays from radium kill them directly."

By checking the new-growth and promoting absorption of hyperplastic tissue and by increasing the lymphocytosis *x*-rays or radium might be expected to exert a very favorable influence on the course of the disease. Their effect on the enzymes or local sensitizing substances may also be a factor

in the good results reported from their judicious use in vernal conjunctivitis.

Personal Experience.—The writer has not used *x*-rays or radium for this disease. His experience during the last eight years with a more simple remedy, in the nine cases coming under his care, has been eminently satisfactory:

CASE I.—June 7, 1911. Alma S., aged ten. Eyes inflamed each spring until fall for last five years. Typical vernal conjunctivitis, palpebral changes predominate. Simple eye wash with adrenalin $\frac{1}{10}$ per cent. daily for one week without effect. First application of $AgNO_3$, $\frac{1}{5}$ per cent., followed by fibrolysin to everted eyelids, brought marked relief within a few minutes. Complete cessation of all subjective irritation occurred within a few days. Treatments continued two or three times weekly until August, and at longer intervals until October. There was no return of symptoms. Kept under observation and the treatment repeated once a month during following winter and summer (1912), there being absolutely no recurrence. Monthly treatments during next summer, 1913; no recurrence. Treated once only in April, 1914, and instructed to report if any recurrence; there was none. No recurrence during 1915. April 10, 1916, had acute catarrhal conjunctivitis, no resemblance to vernal type, no itching, considerable secretion: recovered within one week, using argyrol solution, 20 per cent., twice daily.

CASE II.—1911. Boy, aged ten. At eye clinic, O'Fallon Dispensary, Washington University Medical School. Typical vernal conjunctivitis. Positive relief from discomfort after use of fibrolysin. Case disappeared.

CASE III.—July 12, 1912. Virginia G., aged ten. Residence, Central, Texas. Typical vernal conjunctivitis, palpebral changes causing diagnosis of trachoma by general practitioner at home, with painful and ineffective treatment. Recurrent attacks in spring and summer for four years. Intense itching and considerable photophobia. Use of $AgNO_3$, $\frac{1}{5}$ per cent., and fibrolysin followed by immediate relief. Applications repeated daily for ten days when patient returned to Texas. Prescribed fibrolysin every two days and

a mild zinc solution for daily use; remained comfortable rest of season (report by letter).

May 20, 1913: Mother reports by letter, "Can't come to St. Louis until August." Advised use of fibrolysin every other day and zinc wash as before. Reported in person August 1, 1913. No nodules in palpebral or ocular conjunctiva; very thin opalescent film remains on conjunctiva, but subjectively comfortable. Reported by letter February 19, 1916. Doing well enough to require no treatment since 1913.

CASE IV.—May 16, 1913. Ruth Z., aged twenty-six. Residence, Warren Co., Missouri. Eyes inflamed each year during hot weather as long as she can remember. Worse last two weeks, "on account of housecleaning." Slight proliferation at limbus of right eye. Palpebral conjunctiva shows no sign of vernal conjunctivitis. Used $AgNO_3$, $\frac{1}{5}$ per cent., and fibrolysin, right and left eye. Prescribed zinc sozoiodolate solution, $\frac{1}{5}$ per cent., twice daily.

June 5: Returned. Proliferations now typical of vernal conjunctivitis at limbus, right eye, tarsal conjunctiva beginning to be involved right and left eye. Rendered subjectively comfortable after use of $AgNO_3$, $\frac{1}{5}$ per cent., followed by fibrolysin. Prescribed fibrolysin to be dropped on everted eyelids right and left once daily, stopping zinc solution.

July 3: Doing well until "hot spell," a few days ago. Palpebral conjunctiva now shows typical nodules of vernal conjunctivitis. Remained five days for daily treatments. Use of $AgNO_3$, $\frac{1}{5}$ per cent., and fibrolysin followed by subjective comfort except late at night. Directed to resume zinc sozoiodolate solution, $\frac{1}{2}$ per cent., night and morning, and continue use of fibrolysin every two days. Remained comfortable for remainder of 1913.

1914: No recurrence, no treatment.

1915: No recurrence except slight discomfort at San Francisco Exposition. No treatment.

July 17, 1916: Returned. Inflammatory symptoms began last month, during intense hot spell. Smear shows eosinophile cells. Used $AgNO_3$, $\frac{1}{5}$ per cent., and fibrolysin. Itching stopped immediately after first treatments and did

not recur. Returned home; directed to resume former home treatment. Promised to report any future recurrence. No report to date.

CASE V.—June 12, 1915: John E., aged eleven. Typical vernal conjunctivitis began six weeks ago; marked thickening at limbus right and left. Severe burning and itching. Used holocain solution, 1 per cent., $AgNO_3$, $\frac{1}{5}$ per cent., and fibrolysin. Subjectively entirely comfortable after first treatment and eyes appear better on inspection. Treatments repeated every two days until June 24th, when he ceased to report for treatment because he was doing entirely well.

February 20, 1916: Father reported by request; stated boy had no further trouble and promised to report if he had.

CASE VI.—June 15, 1915. Physician, aged thirty-nine. Conjunctival congestion simulating phlyctenulæ at limbus one or both eyes, recurring regularly in spring and summer. No palpebral signs, no opalescent film. Initial attack twenty years ago nearly coincident with first attack of malaria, which has since shown decided chronicity but no relation between attacks. Discomfort begins as early as April, if weather is dry and dusty, but more noticeable in June and July. Cloudy weather and rain invariably bring some relief. Loss of sleep and travel seems to aggravate symptoms. Bathing eyes with either hot or cold water increases comfort. Wearing correction for astigmatism, cyl. +.75 ax. 90, increases comfort. Euphos, amber, or Crookes' glass seemed to possess little advantage over plain glass for this purpose. Discomfort always less in morning, but often worse during hot evening than during day. Fibrolysin used once on above date arrested the attack for the summer 1915—the latter part of which was spent in Colorado. No recurrence 1916 and 1917. Slight discomfort 1918, and a slight recurrence in April, 1919, during an early warm spell. Being familiar with the rather harmless nature of these attacks, and having very little discomfort during the last two attacks, he is watching for further developments before repeating the treatment.

CASE VII.—April 20, 1916. Frances D., aged fifty-three. Recurrent attacks of vernal conjunctivitis for eight or nine

years, characterized by itching, photophobia, and congestion of ocular conjunctiva. Tarsal conjunctiva smooth, but shows opalescent film; no changes at limbus. Used holocain solution, 1 per cent., $AgNO_3$, $\frac{1}{5}$ per cent., and fibrolysin both eyes. Following day, no photophobia or congestion. Treatment repeated.

Three days later, conjunctival irritation recurred after long automobile trip. Treatment same and directed use of zinc sozoiodolate solution, $\frac{1}{5}$ per cent., at home night and morning. Ten days later, slight discomfort in right eye; used $AgNO_3$, $\frac{1}{5}$ per cent., and fibrolysin in right eye only.

Under observation for fifteen days longer for measurements of refraction, but no further treatment used, as discomfort had not returned. Will report at once if it does.

March 19, 1917: Slight return of symptoms of vernal conjunctivitis; used $AgNO_3$, $\frac{1}{5}$ per cent., and fibrolysin. Three days later, very little itching, but some sensation of dryness since last treatment, which was repeated. Three weeks later, some itching after strong wind two days ago. Otherwise comfortable. Repeated treatment five times during next ten days, after which no further discomfort. Last seen in January, 1918, for readjustment of correction.

May 12, 1919: Reported slight attack of ocular inflammation for a few days in April, 1918; more severe attack this year (1919), lasting nearly a month. Some treatment by neighboring physician.

CASE VIII.—September 8, 1916. Geneva W., aged nineteen. Eyes inflamed for two months. Much itching; worse at latter part of day. Similar attack during summer, 1915. Eyelids show opalescent reflex of vernal conjunctivitis. Used holocain solution, 1 per cent., $AgNO_3$, $\frac{1}{5}$ per cent., and fibrolysin on tarsal conjunctiva. Much better following day, treatment repeated. Two days later, entirely comfortable; treatment repeated. Three days later, slight discomfort; treatment repeated. Entirely comfortable through remainder of season.

May 11, 1919: Her mother answers that patient had some conjunctival irritation during summer of 1918, but "not nearly so bad as before," and no recurrence during 1917; no treatment used since September, 1916.

CASE IX.—January 29, 1919: Lela I., aged nine. Residence, Herculaneum, Mo. Eyes inflamed in warm weather for last three years. Usually begins about April, but itching and ocular congestion with photophobia began several days ago, during this unusual spell of warm weather in midwinter. Typical opalescent film over tarsal conjunctiva, both eyes with tiny nodules at limbus. Mother had similar attacks which began when she was about eighteen years of age. They recurred each summer for five years, and then ceased spontaneously. Examination of mother's eyes revealed rather suggestive, very thin milky film on palpebral conjunctiva, though she has had no discomfort for ten years. Both the mother and the present patient are pronounced blondes.

Used holocain solution, 1 per cent., and $AgNO_3$, $\frac{1}{5}$ per cent., followed by fibrolysin. Returned three days later reporting immediate improvement in comfort and less congestion. The mother did not conceal her surprise, as all previous treatments during her own experience with the disease some years ago, and for the last three years with her daughter, had not been satisfactory. Returned five weeks later. Eyes remained clear for some days, then some congestion at temporal limbus right eye. Palpebral conjunctiva remained smooth, but showed pale opalescent film. Slight congestion at limbus on temporal side in each eye. Treatment repeated and directed to use zinc sozoiodolate solution, $\frac{1}{5}$ per cent., twice daily at home.

May 11, 1919: Mother reported child's eyes had remained perfectly clear for two weeks after last visit, and that symptoms now were so much milder that she did not wish to take her out of school to come to St. Louis for treatment.

This series of cases is too small to permit generalizations, but the experience had been so satisfactory that it was mentioned privately to several ophthalmologists attending the meeting of the Colorado Ophthalmological Society in August, 1915. At least one, Dr. Robert Scott Lamb, had the hardihood to make use of fibrolysin in his own practice. He reports by letter as follows: "My first attempt was the corraling of six chronic recurrent typical and well-marked

cases, well known to have resisted all usual methods, put them in the hospital, under control, and use each night, at bedtime, one drop of fibrolysin in each eye. Imagine my astonishment to find, at the end of ten days, *all were well!* They were discharged from the hospital and requested to report to the out-patient department for observation once a week. There was no more vernal catarrh among them that season."

Dr. John Green, Jr., has kindly furnished the following case report:

"Girl, aged twelve, came under observation June 20, 1917. Ocular history: For the past three summers her eyes have been inflamed, with itching and photophobia. The condition clears up in the autumn. She has never missed a day of school on account of her eyes. Two years ago Dr. Brose, of Evansville, Ind., removed tonsils and adenoids and gave eye drops. Home doctor used 'blue stone.' The patient presented a well-marked case of vernal conjunctivitis of the palpebral type.

"Refraction: R.E., sph. +1.00 = 6 4. L.E., sph. +.75 = 6 4.

"Euphos glasses gave some relief from the photophobia. After a few days' treatment with a boric acid, cocain nitrate, and adrenalin mixture, fibrolysin was started and used every third day for three weeks. During this period the patient was comfortable, the eyes opened more widely, and there was marked flattening of the palpebral plaques."

Of interest in this connection is the report of W. A. Sedwick[35] that in his first case, presented to the Colorado Ophthalmological Society in August, 1917, the lids afterward became entirely smooth under local applications of fibrolysin.

Fibrolysin* was used in the first case, as above noted, be-

* "Fibrolysin $CS(NH_2)NHO_2H_{12}(C_6H_6—OH—COONa)$. Aqua. In order to avoid the pain caused by the subcutaneous injection of the alcoholic solution of thiosinamin (allyl-sulfo-urea), an aqueous solution of this compound has been prepared by F. Mendel. This was accomplished by combining one molecule of thiosinamin with one-half molecule of sodium salicylate. The resulting double salt forms a white, crystalline powder which is readily soluble in cold water. The aqueous solutions are not stable to the action of light and

cause it was believed that the absorption of the hyaline deposits might be accelerated and that an active lymphocytosis might modify favorably the course of vernal conjunctivitis. Clinical and experimental tests had shown that fibrolysin produced local lymphocytosis and promoted the absorption and softening of scar tissue. It had been used locally on the cornea and conjunctiva without injury. In fact, its use seemed to improve the resistance of corneal tissue, to aid materially in the cure of old indolent ulcers, and in checking the progress of acute superficial corneal infections of every type.

The regular and persistent use of the remedy in the first case was possible because the patient, who had suffered much previously, was able and willing to report as directed. She apparently attained a complete cure.

Some of the other cases could not be followed up, but the relief experienced by each, while under observation, was beyond question. In some of the later cases fibrolysin was used as sparingly as possible, both because it was desired to measure the maximum effect of a minimum dosage and because, under war conditions, the preparation disappeared from the drug market, so that the small supply on hand was frugally conserved.

If one may hazard any conclusions as to the best therapeutic method from observations in such a limited number of cases, it would appear to be desirable not to depend on fibrolysin alone, but to retain the use of silver or zinc salts in weak solutions for their beneficial effect on the epithelium. Fibrolysin seems to affect principally the subepithelial tissues.

air, hence are furnished in sterilized sealed tubes containing 2.3 c.c. of a solution, 1.5 parts of fibrolysin in 8.5 parts of water. Each tube represents 0.2 gm. of thiosinamin. This is employed for resolving lupus, glandular tumors, scleroderma, etc. (E. Merck). Thiosinamin,—$CSNH_2$, NH, C_3H_5,—a compound of ammonia and mustard oil, forming crystals of faint garlic odor, slightly soluble in water, readily in alcohol, fusing at 74°."—*Extract from "The Newer Remedies," by Virgil Coblentz, A.M., Phar.M., Ph.D., F.C.S., ourth edition, 1908.*

The use of holocain solution, 1 per cent., just before using the fibrolysin proved to be desirable to shorten the period of burning usually accompanying the instillations of the latter solution.

Apparently two or three times a week are sufficient to produce and maintain freedom from the discomfort, even in severe cases and during the hottest weather. If nothing more had been achieved, the report of that fact would be fully justified by our past failures in this respect.

It seems that treatment at intervals of one month throughout the year can prevent relapses and bring about a cure in some cases. That effort is certainly worth while in the absence of all noxious effects when the remedy is thus used. The use of fibrolysin should not mean the neglect of any measure calculated to promote the well-being of the patient, such as the correction of eye-strain and exposure, nor should the general health be ignored.

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